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Two Mixers Working Abreast on Dunes Relief Highway

The Dunes Relief Highway By-Passes All Towns

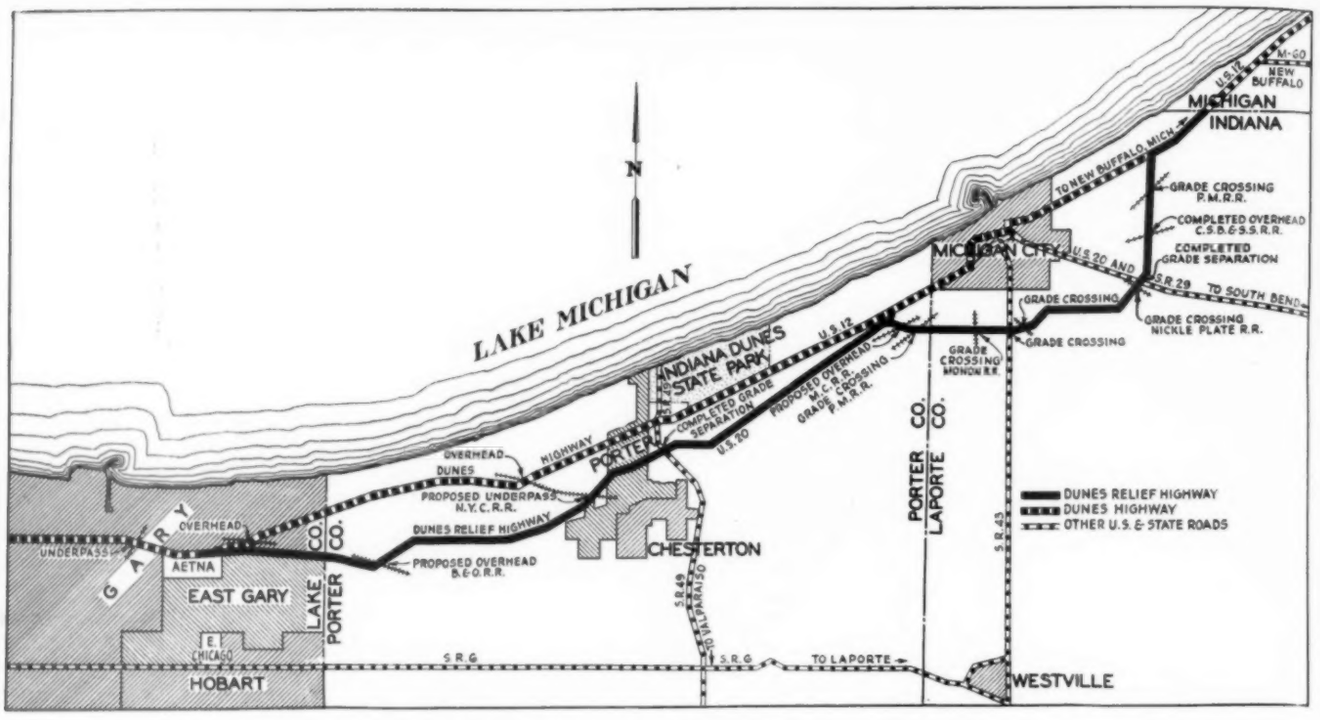
AS its name implies, this road is being constructed to relieve the congestion on the Dunes Highway. It is 40 ft. wide 31.28 miles in gross length, by-passes all towns, has but few and very flat curves and will have grade separations at important railroad and highway crossings. The paving was built for the Indiana Highway Commission and was completed in one season by five contractors at a cost of $1,711,090, which includes drainage structures of less than 20-ft. span, grading, right-of-way markers and everything but bridges and grade separations.

Heavy Traffic on Dunes Highway.—The Dunes Highway parallels the lower end of Lake Michigan, carrying an enormous amount of automobile traffic into Chicago from Michigan, from points in northern Indiana and Ohio, and from the East. It carries an unusually large percentage of trucks, especially during the summer and early fall months when much of Michigan's fruit crop is sent to market on wheels. There are also the long vehicles carrying a half-dozen or more automobiles from Michigan factories, trucks and trailers hauling tires, milk, cement, furniture, and household goods and fleets of drive-aways to add to the general congestion. Even on week-days, traffic is so heavy that long lines of vehicles follow each large truck, waiting for a chance to pass. On Sundays a trip of 40 miles may take several hours.

The new 4-lane pavement is parallel to and about a mile south of this older 2-lane road, beginning at East Gary and extending to the Michigan state line northeast of Michigan City, where it connects with a concrete paved highway recently widened to 40 ft. by that state. Its official designation will be U. S. 20. It is so located that it will also carry much of the traffic from U. S. 12.

Grade Separations.—Six grade separations are planned, one carrying another state highway over the new road, one carrying the present U. S. 20 under the new road, and four carrying the new pavement over or under steam and electric railways. The two highway grade separations and the electric railway overpass were completed in 1931; the others are to be built in 1932. All of the completed structures are of reinforced concrete. The average cost of the two highway grade separations structures whose spans are 49 ft. 4 in. and 52 ft. 6 in., respectively, was $16,000, exclusive of approach grading. The completed railway-highway separation, consisting of five 35-ft. spans, cost $57,164.

The 40-ft. pavement is divided into two, 20-ft. slabs which are in turn divided into 10-ft. traffic lanes by



Dunes Relief Highway and Connecting State Roads

longitudinal joints of the deformed metal plate type. Each 20-ft. slab has a thickness of 9 in. at the edges and 8 in. in the midportion. Concrete is placed directly against concrete at the center line, where the 20-ft. slabs are contiguous. This center joint is a plain butt joint and, since the concrete is thickened along the joint, no tie bars are used across it.

Highway on Virgin Right-of-Way.—Most of the new highway is on virgin right-of-way, in that part of northern Indiana known as The Dunes Section. It is a wooded area, much of which was once bog, and has been partly covered by hills of sand that has blown in from Lake Michigan. The subsoil ranged all the way from peat and black muck to pure, fine sand. Where peat was encountered it was excavated and replaced by stable material, usually sand. Fills around bridges and culverts were made with sand, as were all embankments of appreciable height.

One muck bed was 1900 ft. long and in some places it was necessary to go down 17 ft. to reach firm ground. The material was excavated with steam shovels and replaced by sand hauled by industrial railway. Excavated material was deposited in spoil banks parallel with the edge of the fill. In the first 16 days of operation, when the haul was comparatively short, 10,000 cu. yd. of muck were removed and 16,000 cu. yd. of material dumped into the excavation. The maximum haul was 3,000 ft. A second muck bed was longer, but not nearly so deep.

The deep sand made it nearly impossible to use trucks for grading work on the western part of the road. Instead, excavated material was hauled in 7 cu. yd. dump wagons with caterpillar treads. A 60 hp. tractor pulled each dump wagon at a speed of about 5 miles per hour. Tractor and wagon could turn in a 20-ft. circle.

Two Mixers Worked Abreast in Paving.—On one section two 27-E mixers were used abreast, on a 20-ft. width of pavement. Water was brought to both mixers through a 2-in. pipe line and a single 2-in. hose. The hose was connected to one mixer and carried through

Grading with Large Scraper Hauled by Tractor

Aggregate Was Dumped from Gondola Cars Into Pits

Just Before the Final Belting Laitance Was Removed from the Surface with a Transverse Float 10-ft. in Length

that mixer to the other. The water connection between the two mixers was a section of rubber hose with enough slack in it to allow for small differences of movement as the mixers pulled forward. It was necessary for both mixers to move ahead at the same time and the arrangement worked best when operations were so synchronized that charging and discharging, as well as moving, occurred simultaneously. This made possible an interesting comparison of the efficiency of the two mixers, one of which was new and equipped with automatic control, while the other had levers for each charging and discharging operation. For every batch the new mixer had to wait on the old.

If either mixer broke down the water connection between them could be removed in a few minutes and the disabled mixer be pulled ahead, allowing the remaining mixer to go on working.

Hauling Operations.—Proportioned batches of materials were hauled to the mixers in trucks, which hauled on contract and were paid for the number of batches hauled per day, so there was no additional cost of hauling due to the dual mixers. There were 38 men engaged in concreting, which was about 5 more than would have been used for a single mixer. An extra crew came to work at noon and worked until about midnight, covering the pavement with straw and then getting the subgrade ready for the next day's run.

On this job the north half of the 40-ft. slab was built first, then the trucks used this completed pavement in hauling batches for the other half of the slab. Loaded trucks lined up on the subgrade, in front of only one mixer. The space in front of the other mixer was kept open as an exit lane for emptied trucks. A plank approach was placed at the point where trucks ran off the pavement and onto the subgrade. Instead of throwing a few old planks against the edge of the pavement, the contractor made up approaches about 3 ft. wide and 10 ft. long by bolting 3-in. planks to heavy stringers. He had enough of these so that, as the mixer moved ahead, the approach that would no longer be used was thrown outside the forms and other approaches, previously placed ahead, were used by the trucks. The discarded approaches were then carried forward on a wagon to the places where they would be used again, instead of being dragged ahead by workmen each time the mixer moved. This not only saved labor but permitted uninterrupted trucking.

Shaping the Earth Shoulders

Two finishing machines were used behind the two mixers and two pumps were required to supply enough water for the subgrade, mixers and curing.

Both fine and coarse aggregate were shipped by rail in bottom-dump gondola cars that dumped into pits beside the track. Materials were taken from these pits by two caterpillar cranes and placed in two overhead bins. Such a system eliminated the hand labor of cleaning up cars and made it possible for the crane to get a dipperful at each bite.

The Completed Dunes Relief Highway

18½ Miles Laid in 3¾ Months.—With this outfit the equivalent of 18.5 miles of 20-ft. pavement was laid in 3¾ months. The maximum day's run was 1,728 ft. of 20-ft. slab. The specification requirement that the 20-ft. slab built first be at least ten days old before the adjacent slab was placed caused some delay and there were many minor delays, some of them due to the dual mixers.

Cement for all jobs was hauled directly from the mill by trucks and trailers.

A 3-ft. wide strip of bituminous macadam was constructed along each edge of the pavement on the west 12.5 miles of the highway. Wherever the shoulders and embankment consisted of fine or blow sand, top soil having a depth of 6 in. after compaction, was placed on the shoulders and fill slopes.

The contractors and state representatives endeavored to make the road of outstanding quality. Through their combined efforts and cooperation this was accomplished. One of the indications of quality construction is the smooth-riding surface, which not only makes the pavement serve traffic more satisfactorily, but adds to its life as well. The pavement was opened to traffic in October, 1931.

Street Railway Track Pavements

By R. H. SIMPSON
Chief Engineer, Department of Public Works, Columbus, O.

ONE of the perplexing and complicated problems of the paving engineer is the laying of a paving surface in the area occupied by street railway tracks in public thoroughfares. In many of the smaller communities the problem has solved itself by the removal of the tracks; the abandonment of street railway service; and the substitution of bus lines and trackless trolleys. In the larger cities, however, we still have and will continue to have street railway service that requires tracks in many of our main thoroughfares, which tracks occupy from one-third to one-half the width of the paved roadway.

The location and construction of such tracks in city streets creates a weakness in the pavement that is difficult to overcome. The mere presence of the rails in the roadway causes vehicular traffic to be confined to fixed lanes, which increases the wear and adds considerably to the maintenance cost of the pavement outside the track area, over and above the cost on pavements with similar traffic where there are no car tracks. Then again the vibration of the track structure itself, caused by street car movement, not only affects the pavement in the track area, but is transmitted to the roadway pavement beyond.

It is evident, therefore, that for the convenience and safety of the public who uses these thoroughfares, the most substantial and permanent type of track and pavement construction possible should be adopted, in order to reduce to a minimum the weakness caused by their presence in the street.

Sub-Base Construction.—The sub-base for track construction should be well drained and unyielding. Very little attention was paid to the condition of the sub-base in the earlier days of street railway construction and it is remarkable how well many of the old tracks have withstood the traffic and the action of the elements. In those days the cars were light and the movement infrequent. With the coming of more frequent service and heavier equipment, it soon became apparent that a more substantial structure was necessary. Even now, however, many cities are still using a base of crushed stone, gravel or furnace slag, when such bases for city pavements are generally discarded. Why do we insist on a concrete base under our city pavements and still use a weaker type under the car tracks? It is admitted that in some sections, bases of stone or slag may give satisfactory results. In many localities, however, the conditions are such as to require a more substantial structure under the track if a satisfactory pavement is to be secured.

Early Construction in Columbus, O.—In Columbus, O., the tracks constructed prior to 1912 were laid on a crushed stone base, the stone extending about half way up on the wooden tie. A concrete pavement base 6 in. thick was laid around and over the upper half of the ties on which was laid a surface of granite block, brick or asphalt. Our experience with this construction has proven unsatisfactory. In practically all cases the movements of the track eventually broke up the concrete, loosened the surfacing material and resulted in rough pavement requiring heavy maintenance. A very large proportion of this track, including the paving, has been reconstructed during the past 15 years, as it was impractical to maintain a satisfactory pavement surface over the old track structure.

New Design at Cleveland, O.—In Cleveland, O., it was found that a type of construction somewhat similar to that described above, was hardly suitable for modern conditions and recently about two miles of double track was constructed of a new design. In Cleveland an attempt was made to construct a base that would move with the track structure and would also support the pavement. In this work the track structure is supported upon a slag base made from coarse crushed blast furnace slag. A layer of fine slag is used for tamping under the wooden tie to bring the track to proper grade. The upper surface of the fine slag is carefully shaped to provide an extra depth of concrete under the rail. Six ½-in. steel rods are laid longitudinally in each track just above the ties. A special vibrating machine was used to settle the concrete around the rails and to give a dense mixture. The pavement surface consists of ½-in. slag cushion and the 3-in. vitrified brick. This design called for a 7-in. grooved rail on wooden ties. The entire track structure and the paving surface moves, under street car movement, as a unit. The results obtained from this construction, over a period of years, will be of interest.

Construction at Columbus, O.—In Columbus, O., the local street railway company has used concrete under and around the ties and rails for 20 years. The earlier construction consisted of a concrete girder 12-in. deep and 18 in. wide under and around the ties and rail. This construction while showing an improvement over the earlier design, was not entirely satisfactory and has been abandoned. Since 1914 the local company has used a concrete slag 8 in. thick as a sub-base for all track construction. This slab bridges over any weakness in the soil and prevents ground water from reaching the track structure and pavement base. The track consists of 122 lb. 7-in. grooved rail bolted to 4-in. Carnegie steel ties and is laid on top of this concrete slab. It is then brought to proper grade and held in position by blocks under the ties, leaving a space of about 2-in. between the top of the slab and the under side of the ties. After being brought to proper alignment, concrete is placed under and around the ties and up on the rail about 2-in. This concrete which holds the track firmly in position and acts as a base for the paving surface, rests on the sub-base slab, but is not bonded thereto. The track can therefore be readily removed and renewed without disturbing the sub-base slab. Granite block and brick has been used as a surfacing material in car track areas during the past 20 years.

The results otained from the type of construction described above have been very satisfactory, and the long service with practically no maintenance, shows that cost of the installation is justified. From the standpoint of the city it might be said that the pavement surface is exceptionally good after many years of service.

Acknowledgment.—The foregoing is abstracted from a report of the Committee on Design and Construction, presented at the 1932 convention of the American Road Builders Association.

Adjusting the Highway Viewpoint to 1932 Conditions

By THOS. H. MACDONALD
Chief, U. S. Bureau of Public Roads

THE theme of the exhibit of the Bureau of Public Roads for the 29th Annual Convention and Road Show of the American Road Builders' Association is the physical relationships of the highway and the motor vehicle. That it is now possible to portray these relationships is an accomplishment of research which has taken years to develop to the point that we can talk about them in definitely measured terms with a high degree of confidence. But it would be a narrow viewpoint that would attempt to limit the achievements of highway transport over the past decade to narrow mathematical terms of technical research.

Under the emergency appropriation provided to advance the Federal aid road program for the past year, there were undertaken 2,216 projects, totaling over 13,000 miles of road, in 1,227 counties, or only a little less ratio than a project to every other county. This was a part of the whole Federal aid road program undertaken and does not include the work done without Federal funds by the states, cities, counties or local communities.

400,000 Men Directly Employed on Road Work.—In a year when there was so much unemployment, under the State and State-Federal road programs during the summer months when it is possible to employ the maximum number of men in highway construction, upwards of 400,000 men were given work, and an equivalent distribution of wages to at least double this number to those employed in the production and transportation of materials and in other lines activated by the road funds.

There is general agreement among the highway officials of the country that 80 to 90 per cent of the road dollar is eventually distributed back to labor and personnel employment.

The emergency appropriation called for $80,000,000 with a time limit of Sept. 1. So vigorously was the program pursued by all connected with it, that less than $200,000 composed of small balances remained unexpended when the appropriation expired. The emergency projects alone put under way for the first six months of 1931, called for an estimated total expenditure of $256,000,000. This was a great demonstration of the ability of the road building agencies of the nation, road officials, engineers and contractors, to put under way quickly and carry forward rapidly a largely expanded road program.

Such an accomplishment as this, however, does not measure the real significance of what has taken place in the highway field. A recital of facts and figures is of doubtful use in portraying a broad and definite idea of the real accomplishment in the highway transport field over approximately the past decade.

For nearly two years there has been such a tremendous amount of false information circulated with reference to the utilization of the highways and the dislocation of the prior flow lines of traffic, that it seems an opportune time to present, without complicating the discussion with these argumentative issues, some aspects which are of far greater importance to the public as a whole than the questions which have been so prominent in the public press and elsewhere.

Important Aspects of Highway Utilization.—For many years road contractors, manufacturers and producers of all kinds of equipment, supplies and materials for road construction, have been highly important factors in our economic structure for the employment of labor, and during the past two years this importance has been relatively greater than at any time previously.

We come to the present time, however, with much greater uncertainty than has heretofore existed as to the future. Much of this uncertainty has been brought about by the emphasis which has been placed upon a relatively small part of the use of the highways, that is, that part of highway usage which is competitive with other transportation agencies, which serve to cloud the future of new highway building.

These controversial aspects, projected into a situation already becoming embarrassing by the depletion of the public road revenues and the necessity of limitations upon property taxes, have produced an uncertainty and lack of confidence on the part of the road building industry as to the future.

It is not my intention to enter into a detailed discussion or to bring into this paper any attempted reply to the controversial questions of the utilization of the various types of transportation available. There are four aspects, however, which I wish to place briefly before the road building industry. In these aspects I believe are found those which will have an important, and perhaps the major bearing, upon the future growth of highway building and utilization.

Characteristics of Highway Traffic.—The first of these is the characteristics of highway traffic. Since 1922 the Bureau of Public Roads, in cooperation with a large number of the state highway departments, has been making studies of highway traffic and the detailed aspects of highway transport. These studies have included states from Maine to California.

There are areas of intense industrial development, and areas of almost no development. Here are some of the facts which have been found in these studies.

First. The predominating use of the highways is by privately owned passenger automobiles. In the eleven western states, on the Federal aid system alone there were more than 20,000,000 daily passenger-car miles of road usage. In the states of Pennsylvania and Ohio this usage ran to about 6,000,000 miles daily. This immense use by privately owned automobiles approximates 85 to 90 per cent of the total volume of highway utilization.

Second. The use of the highways by either automobiles or motor trucks is predominantly local, taking the states as a whole. In such states as Pennsylvania and Ohio, typical of the more thickly populated, this local use is from 85 to 90 per cent.

Third. The predominating volume use of the roads by both automobiles and trucks is for short distances, that is, above half of the use will be under 30 miles.

Fourth. The ownership of both automobiles and trucks in use on the highways is predominantly private.

Since there has been a notable drop in the amount of transportation required, particularly for local service, there has been a growth in the longer distance travel of busses and trucks. They, like many others, are seeking employment. There has been a certain amount of business taken over from the railroads by trucks and busses operated in the public or common carrier service, but this is an inconsequential part of the total volume use of the roads.

Changes in Merchandising Methods.—A great change has taken place in methods of merchandising. There has been a change from relatively large to much smaller inventories resulting from highway transportation quickly and easily available. This change is having a profound effect upon transportation methods. For example, in Ohio, out of a grand total of 84,000 retail establishments, 36,000, or 43 per cent, handle goods that require daily replenishment. In Maryland, of a grand total of retail establishments of 21,000, about 9,000, or 42 per cent, handle supplies that are replenished day by day. These are only two instances that indicate in a concrete way a service which has become established as a daily highway use.

It would be possible to carry this discussion into unnecessary lengths to demonstrate the intimate relationships which have been established between our whole population and highway transport. It is not necessary to go into these to point to the conclusion that no material part of the development of our highway system is contingent upon any of the services which are now in controversy. The need of highways will go on and on because of their highly localized services which belong to them exclusively.

The long-distance traffic may be termed a by-product, important in itself, but having practically no effect upon the necessity for the improvement, or the volume of use, of improved highways. Thus, from the standpoint of the future of highway building no matters now in controversy as to the carriage of persons or commodities by the various public transportation agencies, regardless of how they are finally composed, will affect more than a minor percentage of the use of the highways.

Coordination of Efforts of Highway Industry.—The second point that has had a profound bearing upon the tremendous developments of highway transport is the coordination of effort by agencies behind the building and use of the highways. These agencies are primarily the highway officials and engineers, the high contractors, including their organizations, and the manufacturers of all types of road and automotive equipment. This latter group includes not only the motor vehicle manufacturers, but many of the accessory manufacturers, including as an important group the rubber tire industry.

The major advances in this field are:

First, the improvement in engineering designs, in contractors' methods, in efficiency and adaptability of equipment, which resulted over the period of five years from 1924 to 1929, is a constantly decreasing index of road costs before there was any effect from the present depression. The decrease in road costs for the five-year period from 1924 to 1929, taken from unit prices of Federal aid projects, was about 27 per cent. During this same period there was a constant increase in the quality of the roads produced generally. The road contractors and equipment manufacturers are to be credited with a large part of this decreased cost through improved organization and better methods, which permitted higher production with the same organization cost. Better engineering designs, better inspection, and a pride in their output on the part of both contractors and engineers, produced at a constantly decreasing cost, a constantly better quality and more durable roads.

The composite prices for 1931 have been about 20 per cent below the average cost for the 5-year period, 1925-1929. This latter reduction has to a large extent been due to lower prices for materials and to some extent lower prices for labor; but the general road costs which are now around 45 per cent lower than the peak costs for 1924 would not have been possible without the improved production methods and equipment and better engineering practices which have been developed.

Second, the important adjustment between the highway and the motor vehicle that has taken place has been accomplished through the cooperation of the motor vehicle manufacturers, and the tire manufacturers and the highway engineers. Only a few years ago the heavier loads were all carried on solid rubber tires. Pneumatic tires had not been developed capable of carrying the heavier wheel loads. When, through the process of experimentation and research, it was found that the use of solid rubber tires under the heavier loads resulted in high impacts on road surfaces, causing depreciation in both the vehicle and the road, the tire manufacturers devoted earnest and successful efforts to the production of heavy duty pneumatic tires.

Also, when, through research, it was found that the wheel load or axle load rather than the gross load is of major importance in the effect upon the highway structure, the motor vehicle manufacturers re-designed their larger vehicles to increase the number of axles and to place them upon either the high pressure or balloon type of heavy duty tires. These two developments are of outstanding importance to the future of highway transport in their effect not only upon the service to the public, but also upon the public's pocketbook which, during these times, is highly important.

Today the highway transport industry is a highly convincing demonstration that highway officials, road contractors, equipment manufacturers, material producers, motor vehicle and rubber tire manufacturers have cooperated to bring to the public highway transport at a constantly decreased cost, both for the roads themselves and for the transport service; and these decreased costs are not small but are of large magnitude.

The third important aspect is that of the future highway program. In some particulars this, at the moment, is not quite favorable.

Federal Aid Highway Program.—For two years the states and the localities have put into road construction every possible dollar of road income because of the demand to furnish employment. The Federal aid highway program for 1931 was as follows:

FEDERAL AID HIGHWAY PROGRAM, 1931

	Federal Aid	Total Cost
Work yet to be done on going program Jan. 1, 1931	$ 58,000,000	$131,000,000
New work initiated	136,721,689	283,637,422
During year	79,210,719*	
Total	$273,932,408	$414,637,422

*Emergency Advance.

The emergency Federal appropriation of $80,000,000 made in December, 1929, was a very large factor in

putting this work under way rapidly during the first six months of 1931.

With the Federal funds now available the possible Federal aid program for 1932 is as follows:

POSSIBLE FEDERAL AID HIGHWAY PROGRAM, 1932

	Federal Aid	Total Cost
Work yet to be done on going program Jan. 1, 1932	$ 35,000,000	$ 79,000,000
Possible program of new work using all available Federal aid funds	113,879,088	261,190,568
Total	$148,879,088	$340,190,563

It will be noted that this is the possible program. I do not believe it is probable that under existing conditions the program will reach the possible figure of $340,000,000 which is $74,000,000 under that for the preceding year.

Sources of State Highway Funds.—In addition to the Federal aid program, there has always been a large state program. For 1930 the state funds available for expenditure came from the following sources:

STATE HIGHWAY FUNDS, 1930

		Percentage of total funds available for expenditure
1. State tax and appropriation from State treasury	$ 43,317,991	3.8
2. Special motor taxes	700,911,184	61.7
3. Miscellaneous income	17,083,821	1.5
4. Transfers from local units	60,609,297	5.3
Total current tax income	$ 821,922,293	72.3
5. Federal aid	92,462,836	8.1
6. Bonds	222,288,308	19.6
Total funds available for expenditure	$1,136,673,437	100.0

Of this total income, 19.6 per cent came through the issuance of bonds. While these bonds were predicated upon the income from the gas tax and motor vehicle license fees and did not impose a tax upon property, the market for such bonds at the present time is practically non-existent. It is not probable that the states will have available any considerable bond money for this year's consruction program.

I do not anticipate the same percentage of transfers from local units.

Diversions from Gas Tax and License Fees.—These two items together, for 1930, constitute 25 per cent of the total funds available to the states. In he meanime, there have been in a number of states diversions from the state highway funds of the receipts from the gas taxes and motor vehicle license fees.

A study for 1929 shows the following diversions:

DIVERSION OF THE REVENUE FROM HIGHWAY USER TAXES AND IMPOSTS FOR OTHER THAN STATE HIGHWAY PURPOSES, 1929

1. To secondary roads	$122,379,000	in 34 States
2. To city and town streets	16,743,000	in 8 States
3. State general fund	95,000	in 3 States
4. To harbors and docks (Mississippi)	189,000	in 1 State
5. To schools	9,271,000	in 3 States
6. River channels (New Jersey)	80,000	in 1 State
7. Administrative and miscellaneous	1,618,000	in 6 States
Total	$150,375,000	

There has been a considerable increase in these diversions since. Because the special taxes have been accepted by the public with better grace than any other taxes, have been easy to collect, and have grown in amount from year to year at an unexpected rate because of the one fact that the public desires an increased mileage of new roads and a meticulous maintenance of the existing ones, the tendency to reach into these special taxes for other purposes is the most alarming one with which we have to contend so far as the future of a stable and adequate road program is concerned.

Possible Adjustment to Meet Present Conditions.—As a fourth and final point, there is the matter of possible adjustments to meet present conditions, some of which are now under way, and some of which entail material modification of our present methods and existing organizations.

There are at present on the Federal aid system 193,000 miles of main roads. Federal funds have been expended on 109,000 miles, leaving about 85,000 miles on which no Federal funds have as yet been used. Some of this mileage has been improved by the states, but a very large part of the 109,000 miles has not been improved as yet with an adequate type of surface. Our whole road building policy has been typically a United States policy of mass production, of extending service rapidly over a large mileage through first-stage improvement, and of bringing these roads up to the necessary higher type of improvement while using them under a constantly growing traffic. The result of this policy has been to make possible large earnings by way of the gas tax and motor vehicle licenses paid for the use of this enlarged mileage thus secured. This income for 1930 paid all but about 3 per cent of the state's contribution to the cost of the state programs. In addiion in 1929 there was allocated to other purposes $150,000,000 and a larger amount in 1930.

In 1930 the Federal road aid amounted to only 8 per cent on the state's income for this purpose. State property taxes amounted to only 3 per cent. The remainder came from the road user taxes, bonds predicated upon these taxes, or from miscellaneous sources.

The very small contribution made from state property taxes could be withheld without the effect being particularly noticeable.

The states which retain intact the income from the road user taxes have no difficulty in meeting the Federal aid many times over. It is only the states which as a legislative policy divide these taxes back to the counties or other subdivisions, that have difficulty in financing a reasonable state program, or in meeting Federal aid without property taxes of any kind.

Effect of Federal Aid.—Federal road aid, by holding the expenditure of road user taxes imposed by the states, to a coordinated system of highways, not only between the states but for the nation as a whole, has had a profound effect in providing quickly a continuous system of roads which is earning a very large annual income for the public; and in holding construction to the standards that are necessary for economical maintenance. Federal road aid has been a large factor in bringing constructive economy into our expenditures for improved highways.

In addition to the system of main roads, there is no greater desire existing on the part of the public than to secure an adequate system of secondary or farm roads.

Federal aid, while it is directly applied to the Federal aid road system, has helped to make possible the

taking over of local roads as a state responsibility and the adding of these to the state systems.

In 1921 the state highway system consisted of 203,000 miles. In 1930 it contained 324,000 miles. In that 9-year period there was an increase of 121,000 miles of roads, lifted from the county systems and added to the State systems, to be constructed and maintained at the expense of the states which means at the expense of the road users. During the same period about 109,000 miles of roads received Federal funds.

Since the roads taken over by the State include those most heavily traveled, Federal aid has been one of the major factors in making it possible to relieve the burden of road taxation upon the counties and local units which are in the main supported from property taxes. The relief by Federal aid of local property taxation is strikingly illustrated in Wisconsin. In 1930 the cost of Federal aid roads was paid 17.8 per cent from Federal aid, 59.2 per cent by the state from road user taxes, and 23 per cent by the counties. The state trunkline roads not on the Federal aid system were paid, 59.8 per cent by the state and 40.2 per cent by the counties. That is, the entire Federal contribution was applied to decrease the cost to the counties of the Federal aid roads.

Federal Aid Revenue from Individual Taxes.—It has been stated that Federal aid takes from the rich states and gives to the poor states. Most of the states as such pay no road taxes, but in a few, small property taxes combined with miscellaneous revenues and appropriations, total for the total state road programs about 3 per cent. But the revenues from which Federal aid is paid are not state taxes in any sense. They are individual taxes and there is no justification for claiming that Federal income taxes are any part of the State revenues. The income of the wealthier individuals and large corporations of the United States, from which the major portion of the Federal taxes come, are the results of production and sales in all of the states. The profits on the mines of Arizona accrue to individuals in the eastern states, and the income tax is credited to the district in which they have their residence. If Federal income tax were credited to its source rather than purely arbitrarily to the place where it is paid, we would have a very different distribution of the Federal income tax payments, and there is absolutely no basis for any State to claim that the Federal income taxes paid in that state belong to the state or are taken from the state. The return throughout the United States of a certain part of these revenues for road improvement is probably one of the fairest distributions of this form of taxation that could possibly be devised, and one of the most healthy for the good of the nation. Thus, we find the Federal road aid and the income from the road user on the main roads and streets of the nation assisting in lifting the burden of taxation from the rural areas which have gone through an unprecedented period of capital depreciation and loss of income.

Consolidation of Smaller Road Units.—It does not seem possible to go much further in this direction at the present time, since there must be some assistance given to the cities and towns on their streets which are parts of the main state highway system, and it is fair that this shall come about. But there is an adjustment which can and must be made in the management of finances for rural roads. Improved methods of travel and the development of equipment capable of much greater production both in construction and maintenance indicate the desirability of consolidating the smaller road units into larger single units. In some sections it would possibly be sufficient to consolidate all units under the county. In others, a number of counties can be consolidated into one district. There has already been progress in this direction, and a considerable number of states have extended their facilities for direct or general engineering supervision and administration as well as financial help. There are many counties where the road problem is sufficiently large that the road organizations should be maintained. To attempt to place all of these counties under a single state administration would make an unwieldly and inefficient machine. But there is no doubt that through cooperation between the state highway departments and the county engineering units, a correlation and unification of results could be secured at a lessened cost. We have more than 3,000 counties in the United States. A large number of these could be consolidated for road purposes at least with a resultant lowering of overhead costs, and the doing away with inefficient administrative boards. Only such a reorganization can effectively increase the field for efficient and economical engineering and contracting in the building of local or secondary roads.

Elimination of Small Taxing Units Desirable.—There is a tremendous reaction against taxation, particularly the taxation of real estate and agricultural property. So long as taxation authority is vested in the very large number of boards existing and so long as the incessant demands for expenditures for public improvements and for other purposes have their impacts upon these same boards, there is little possibility of any rapid relief from taxation.

It is possible to put our house in order in the highway field, taken as a whole by the elimination of small taxing and expending districts, by the application of modern methods of engineering, construction and maintenance to the problems of consolidated districts. These are necessary to secure the continuation of an adequate road program if road revenues are materially reduced.

I believe that we are on a permanently lower level of prices for road work, but it is impossible to expect and unfair to ask that today's prices be continued when the nation's affairs have readjusted themselves to a more normal basis. Yet, I do not see in the present situation any real economic trends that are antagonistic to a continuation of a large annual program of road work or the lessened importance of highways and their utilization to the public; rather the opposite.

There should not be, and I do not believe there does exist, any hostility on the part of responsible individuals engaged in the highway field in whatever activity, toward other agencies of transportation, but rather a desire to cooperate and to coordinate highway transport with other agencies, retaining only the fair field which it can economically fill.

It is my hope that under the existing difficult conditions the utmost spirit of friendliness and good will shall prevail within the highway industry through the coming year in the effort to improve our whole economic condition.

Acknowledgement.—The foregoing is an address presented Jan. 11 before the General Highway Planning Meeting at a convention of the American Road Builders Association.

County Officials' Resolutions

STRIKE

While Iron Is Hot

With adequate and stable income counties will find it possible to plan coordinated systems of profitable and economical highways in orderly and balanced manner over a period of years that will meet transportation needs of the county

COUNTY units of administration in highway affairs was endorsed in crowded sessions of leaders in county activities from all sections of the country at the County Highway Officials annual meeting during the 29th annual convention of the American Road Builders Association in Detroit, the week of January 11.

"Resolutions adopted set forth the policies and give a 'creed' to be followed by county officials in their administrative work and in their relations to other governmental units," stated Otto S. Hess, retiring president of the division. "The most important problem of county highway work is the establishment of mutually satisfactory relations between a state and the counties in respect to administrative and financial affairs."

Mr. Hess believes that a stable and adequate income, and a well-defined sphere of activity are necessary for the development of county highways in an orderly and balanced manner. If these two essentials are provided counties will find it possible to plan their work for a period of years to improve a coordinated system of profitable and economical highways to meet transportation needs on roads under county jurisdiction.

RESOLUTIONS

Adopted by County Highway Officials Division American Road Builders' Association Convention, January 11-15, 1932, Detroit, Michigan

Your Committee on Resolutions reports:

The reports of the subcommittees at this meeting are outstanding in quality. They represent the unanimous agreement of able men from all sections on general principles of highway administration. Many minor points were actively debated.

We believe that the best service may be rendered to the people of these United States in the construction of ways for highway transportation:

1. Centralization should be effected for only determination of policies;

The national conventions of the American Road Builders' Association and affiliated organizations afford the proper medium of centralization necessary to determine such policies for county highway work in the representative manner traditional to the American form of Government.

2. The administration and management for the construction and maintenance of each highway should be vested in the unit of government nearest the people interested or affected, providing such unit is of suitable size to administer the work competently and effectively and also having regard to the primary purpose of such highway.

Specifically we believe that the state governments should build the national and state highways, the county governments, the county highways and such other local roads, other than city streets, as are not economically handled by lesser units of government.

It would be a hardship on our people to travel a greater distance than to their county seat to make representation relative to their road requirements directly to the persons in authority.

The danger of political bureaucracy in any too centralized form of administration is apparent. Direct accounting of ad-
ment and should be preserved.
ministrations to and personal contact of administrations with the people is a contemplated check and balance in our govern-

3. Voluntary cooperation between all road building organizations is recommended and it must be founded on mutual respect.

4. All the taxes paid on motor fuels and for the registration of motor vehicles are necessary for use in the maintenance and construction of highways, and they should be used exclusively for that purpose and apportioned in an equitable manner for the development of all highways. Apportionment of these monies should be in general accord with the recommendations of the report "Administrative and Financial Relationship of State and County."

The motor vehicle and gasoline tax is the nearest practicable means of collecting a metered charge for the use of the roads; to use this money for any other purpose than highways is a breach of faith with the people.

THEREFORE, Pursuant to the beliefs set forth above and in conformity with the reports discussed and adopted, we propose for tentative adoption the following policies to be observed by county highway officials:

1. To use all reasonable endeavor to cooperate with other road building units and particularly our state highway departments, but not to the extent of being servile.

2. To do all work wih the objective of accomplishing some definitely adopted plan.

3. To anticipate the adoption of uniform accounting for state and counties, and to conform as near as practicable with the outline for uniform accounting set forth in the report on this subject presented at this meeting until a final accounting system is approved.

4. To adopt so far as practicable the standard form of contract and specifications used by the state in which we are resident, and to have all divergencies of construction clearly shown upon the plans and specified forms for the work.

5. To use in general the progressive or stage type of development for the highways under our jurisdiction.

6. To use low cost types of improvement where they are adequate to the traffic needs.

This should not excuse slovenly, inadequate, and therefore uneconomic work. It often takes more skill to supply adequate service at a low cost than to build the more spectacular type of standard construction.

Fundamental Highway Terms Need Definition

Concensus of Opinion on Explanation of Concepts Desired

By VIC BROWN
Associate Editor

CLARIFICATION requires accepted definition of the fundamental concepts of a subject to be clarified. At present the highway industry is muddled in its basic thought on three or four extremely fundamental conceptions. In order to start a discussion of four of these elements this is a request for engineers and contractors to comment on the definitions requested below. In sending me your answers please confine your definition of each term to one sentence and if you think necessary to support your definition with illustration be as concise and to the point as possible. Remember that in a definition of a term, no varying form of that term appears in the definition.

The Century Dictionary explains the word definition in the following terms:

Definition: A statement of the signification of a word or phrase, or of what is essential to the conception of any given thing; and explanation of how any given kind is distinguished from all other kinds.

What is your definition of:

1. *Construction*
2. *Maintenance*
3. *Reconstruction*
4. *Widening*

If widening, fundamentally, falls under one of the other three classes of work your definition should be so worded as to include it.

C. N. Conner, Associate Editor, suggests a tentative definition of construction, for example, might be:

Construction: That type of treatment for road improvement which has appreciable, i.e., measurable, residual value should be classed as a type of construction rather than maintenance.

What are your definitions?

(*Continued from previous page*)

7. To arrange before any bond issue is promoted or approved for highway construction that such promotion be preceeded by an investigation of the ability of the county to pay the bonds; of the need of the county for the roads; of the location of the roads; and as to whether the plan is economically sound and adequately conceived.

Technical, lay, legal and financial opinion should be consulted. Any community contemplating a bond issue should obtain a copy of the report, "Methods of Promoting Bond Issues."

8. To make all purchase of machinery and equipment in accord with good business practices and in general to comply with the conclusions and recommendations set forth in the report on "Purchasing Equipment Practices."

RESOLVED that we believe the greatest efficiency of operation is obtained when the Board of Commissioners is charged with responsibility not only for the raising and apportioning of county highway funds but also for the selection of the executive engineer to direct county construction and maintenance operations.

FURTHER, we believe that in every state where the engineer is now required to obtain office through popular election legislation should be considered to provide that the engineer shall be appointed by the controlling board conditioned only that the engineer shall meet suitable qualifications through education, training and experience.

RESOLVED that we deeply appreciate the fine sentiment of approval of the service rendered by the American Road Builders' Association as expressed in President Hoover's telegram.

We pledge to the President of the United States and through him to the people of our nation our utmost endeavor to the end that the unemployment condition will be abated.

And Further, we pledge our continued efforts toward the well being of our nation through the orderly development of facilities adequate to serve the transportation needs on secondary highways.

President of County Division,
OTTO HESS, Engineer-Manager, Kent County Road Commission, Grand Rapids, Michigan.

Resolutions Committee
K. I. SAYER, Ishpeming, Michigan.
J. W. MAVITY, Newton, Kansas.
FRED HOUSER, Atlanta, Georgia.

Engineer-Executive,
CHAS. E. GRUBB, National Press Building, Washington, D. C.

Application of Road Oil to Earth Surfaces and Subgrades

By F. V. Reagel
Engineer of Materials, Missouri State Highway Department

THE practice of oiling earth surfaces is of long standing. The results of a recent survey, however, seem to indicate that the practice has not as yet developed into an art and in a large number of instances receives very little technical supervision. For example, although oiling of this type is probably being performed in most states, only eight state highway departments will admit to having exercised any supervision or to having any particular knowledge of the essential factors making for satisfactory results with this type of work.

Road oil applications have been generally considered as only temporary maintenance expedients. We believe that this material has not received the serious consideration as a construction material that it merits if handled with a view to obtaining the maximum of service from its use. The addition of large mileages of low cost, farm-to-market roads to highway programs, should introduce a new and increasing field for this type of construction.

In this paper we shall endeavor to describe the practice in a single state, Missouri, and to summarize the results obtained and the conclusions drawn from following this practice.

All of you are probably more or less familiar with the use of road oil for the purpose stated. We have nothing particularly new or unique to offer except perhaps to sell the idea that increased care and attention to a few fundamental considerations in connection with the use of oil an earth road surfaces or subgrades will produce considerably improved results over the general practice of haphazard oil application and oiled application maintenance.

Construction.—Special attention is and should be given to the preparation of the subgrades of roads to be oiled. The road is brought to the proper cross-section and kept there by maintenance with a motor grader. The best results are obtained when the oil is applied as soon as possible after the road has been brought to this condition, providing there is no appreciable amount of dust on the surface. The final blading usually exposes soil with the normal amount of moisture present, this condition being especially conducive to uniformly excellent penetration of the oil. As the capillary moisture recedes from the surface, it is replaced by the oil, enabling it to come into intimate contact with the soil particles.

Should an obnoxious quantity of dust be present on the surface, the usual practice is to wait for a rain to consolidate it. If this procedure is not practicable, as much dust is bladed to the side of the road as is possible without disturbing the compacted surface. A rain during an oiling operation interrupts the oiling only until the road has dried sufficiently to support the distributor without rutting.

The regular quantity of oil applied in 1931 was as follows:

Original treatment for a road consisted of three applications, totaling 1 gal. per square yard. The initial application was ½ gal. and the two subsequent treatments each ¼ gal. Roads reoiled in 1931 received two treatments, each of which consisted of ¼ gal. per square yard. This was varied in some localities and under certain circumstances, but, in general, strict adherence to these limits was observed.

Cover material is used only if it is found necessary to soak up some of the oil because of extremely slow penetration. If puddles of oil form on the surface and remain, then dirt is added as a blotter. Otherwise no cover material is added to oiled earth roads.

Ordinary traffic is detoured around oiling jobs, being returned to the road only when all the oil has been absorbed. In addition to the hazard and nuisance caused by the slick condition and the spattering of fresh oil under traffic and the accompanying interference with the smooth and continuous operation of the oiling by traffic, a serious effect of early traffic on a freshly oiled road is the interruption and disturbance of uniform absorption of the oil by the surface. If no detour is available, for the accommodation of traffic, the road is oiled by halves. In these circumstances, some of the traffic will be forced to use the freshly oiled side, rutting or marring to some extent the newly oiled subgrade.

Conditions.—Climatic conditions, type and volume of traffic, character and types of soil and character of alternate construction available, are all of interest or have a direct bearing on the utilization of road oil on earth as a part of a road building program.

No locality in the entire state of Missouri is entirely free from the detrimental results of freezing and thawing. Winter in Missouri means that our roads will be forced to undergo a number of repetitions of this cycle. A final thawing of all frozen surfaces usually accompanied by frequent showers occurs in the spring. An excellent surface is necessary to combat the evils presented by the water on the road together with that beneath the surface, a condition which would result from cracks in the surface or seepage from side ditches or capillarity or any combination of the three. During the summer oiling season, occasionally quantities of oil are lost, being washed off the roadway by sudden rains during and immediately after the oiling operation.

Traffic.—Traffic on the greater part of the farm-to-market system of Missouri is both local and interurban and consists of both iron and rubber tired vehicles. During certain seasons, much heavy farm machinery is driven and hauled over these roads. Often this type of traffic is injurious to the surface because cleats and lugs are not removed from the wheels. In volume, traffic will range from a few to 800 vehicles per day on routes which have been successfully maintained from year to year as oiled earth roads.

Soils.—The soils of Missouri, based on gradation or texture classification, range from gravelly or stony loams to clays.

The soils included in that part of Missouri north of the Missouri River are principally of either glacial or windblown origin. The glacial soils have been derived

from the glacial drift material deposited by the Kansan glacier. Soils which have been almost entirely derived from this material are confined to twelve counties included in the rolling prairie region, located in the north central part of the state. The texture of these soils ranges between clay-loam, silty-clay loam or clay. According to the soil group classification suggested by the Bureau of Public Roads, most of these soils are included in the A-6 group, colloidal clays.

The windblown soils are known as loess and occur most extensively along the Missouri and Mississippi Rivers. The thickness of these deposits gradually decreases and the texture usually becomes finer as the distance from these streams increases. This loess soil also occurs as a rather uniform and relatively thin mantle over the glacial drift material which underlies most of the level prairie region located in the northeastern part of the state. Texturally, these soils are classed as silt-loams or silty-clay loams. Generally, they conform to the Bureau of Public Roads groups A-4 or A-5 requirements but occasionally when intermixed with glacial material they may exhibit physical characteristics similar to A-6 or even A-7 groups.

The Ozark border and Ozark upland regions are located south of the Missouri River. The soils are principally of residual origin. Varying percentages of gravel and stone fragments are usually present in the soil profile. The percentages of gravel and stone fragments depends to a considerable extent upon the resistance of the different strata of parent rock to the weathering agencies. On a basis of texture, these soils are classed as silty-clay loams, gravelly loams and stony loams, Group A-2 and A-6 soils predominate. However, some group A-4 soils are encountered in isolated areas where the parent rocks have been covered by loessial deposits.

Six counties located in the extreme southeastern corner of the state are included in what is known as the southeast lowland region. The soils are alluvial in origin, having been deposited by the Mississippi flood waters. Texturally, they are classified as loam, sandy loam, silt loam or clay. The clay soils usually are of the colloidal-clay type and contain a considerable amount of organic matter. These soils, as is frequently the case in soils of alluvial origin, are exceedingly variable in texture. Soils conforming to all of the groups between A-3 and A-7 inclusive are encountered in this section of the state.

In the southern portion of the state, there are available locally abundant supplies of gravel and similar types of granular surfacing. In this general territory, there is literally not much earth available for oiling.

In northwestern Missouri, however, oil has been considerably used because in that section there are but few acceptable gravel deposits or stone quarries and those are widely scattered.

The farm lands in this region are among the most productive in the entire state and consequently there is an abundance of crops of various kinds to be transported to market towns. This, in turn, means that there is a very real need of all-weather roads to such towns.

Negligible quantities of available local materials necessitate shipping in surfacing materials at an excessive cost. The Missouri Highway Department feels that the best expedient in such cases is the application of road oil, which, for the past four years, has produced cheap and serviceable all-weather surfaces on both secondary and farm-to-market roads.

Discussion of Results.—Within the limits of length and time of delivery set for this paper, we can only attempt to summarize the results of our investigational work and later practice in connection with the application of road oil.

A systematic investigation of oiled earth roads of various lengths in different localities was undertaken in 1928. The investigation was carried forward on 29 sections, comprising a total of 224 miles of road. Supplementary surveys were conducted at intervals until May, 1929, and later condition surveys were made in the spring and fall of 1931. A complete cooperative report by the U. S. Bureau of Chemistry and Soils, the U. S. Bureau of Public Roads and the Missouri State Highway Department was made in the May, 1931, issue of the publication by the Bureau of Public Roads. This report covers:

1. Condition prior to oiling
2. Preparations made before application of oil
3. Pertinent information at time of application
4. Surface conditions at times of inspection subsequent to oiling
5. Special subgrade soil studies
6. Conclusions drawn from the preceding

The first conclusion drawn was to the effect that road oil of the types included in the study is an efficient material for use in the treatment of earth surfaces to provide all weather roads, provided applications are made to suitably prepared surfaces, adequately drained and repeated as needed. Also adequate drainage, both subsurface and surface, is essential to the satisfactory service of oiled earth surfaces. Adequate drainage on flat topography requires greater crown than is ordinarily provided on graded earth sections. It is interesting to note, however, that lack of drainage is about the only condition that seems to be able to prevent a fair return on the investment in a road oiling job. The fact should be kept in mind, in the discussion or illustration of defects, that, in the main, the effects of practically all unfavorable conditions are generally localized and render only relatively small areas of surface inconvenient to traffic. Oiling the surface is, however, a splendid poor drainage detector, practically the only areas failing completely to carry traffic being traceable to lack of drainage. It is sometimes a problem to convince maintenance and construction operators that minor lack of drainage such as small shallow dips and lack of crown, such as will permit the retention of water puddles on the surface, constitute poor drainage. Slight exaggeration of crown will go far to eliminate trouble from this source.

General profile is not a factor affecting the service of oiled earth surfaces except as variations may influence the efficiency of drainage and the character of the subgrade material.

The type of oil, as regards basic crude source, is not a major factor, all types yielding fairly satisfactory results with all types of soils, other conditions being favorable. Some oils give somewhat better results than others with particular soil types but all give fairly satisfactory results.

All soil types so far encountered can be efficiently treated with road oil.

The soil type is an effective factor because of the physical characteristics of the various soil layers exposed to the application of oil. The physical characteristics of the subgrade soils affect the final results according to whether the soils require only the waterproofing qualities of the oil or in addition require an increase in their cohesive properties. The condition of the surface with respect to dust, hardness of crust, and moisture content at the time of application of the

oil directly reflects the physical characteristics of the soils. The uniformity of penetration is controlled by the uniformity, texture, and density of the several layers of a soil type.

Soils lacking cohesion and inclined to absorb water very readily in quantities sufficient to cause rapid loss of stability (represented by friable silts), may be more effectively treated with oils having ductile and cohesive bases. Soils which possess cohesion in a high degree and which, when in a stiff or plastic state, do not absorb additional water unless manipulated (represented by clays), do not require treatment with oils having cohesive bases, as water-proofing without binding will insure fairly satisfactory results. Soils which possess properties from each of the groups mentioned above but can not be placed definitely in either one may give better results if the quantity of oil applied is increased.

It might be of interest in this connection to give a brief statement of the physical characteristics of the soil types in which we are interested. For the purpose of getting the picture that we desire, we may for our purpose forget for the moment the very excellent and detailed classification as outlined by the soil scientists and create a rough classification of our own consisting of three general classes, clays, silts and sandy or gravelly soils.

The clays are largely composed of particles less than .005 m.m. in diameter. They would pass through a sieve having six-million openings per square inch. The surface area of one cubic inch of clay would equal, if assembled, as much as one acre. Naturally clays possess high cohesion due to surface tension between such small particles and the moisture in the voids, or, in other words, due to the surface tension of adsorbed water. This adsorbed water is held firmly at all temperatures up to the point of fusion of the clay particles. If we think of this layer of adsorbed water as being or approaching one molecule in thickness, we can see that the separation of two soil particles will require sufficient force to break the bond between the water molecule and the particle surface as the disruption of the water molecue itself is practically impossible. Making a summation of this force in an acre of area, we can readily see the reason for the high cohesion of clays containing only their normal moisture content. The addition of water in such quantities as will increase the thickness of film to several molecules will immediately result in the cohesive force diminishing and approaching the viscosity of water, which is very small.

With additional amounts of water, clay immediately tends to flow, the tendency increasing with added increments of water. Clays have no appreciable internal friction as the particles are so finely divided that they offer very little resistence to movement one over the other. All physical stability in soils is dependent upon the summation of cohesion and internal friction. Clays possess practically no internal friction but do possess abundant cohesion if the moisture content does not exceed the normal adsorbed moisture. For stability, then the moisture content must be prevented from increasing, by the treatment with road oil or by other means.

When dry, clay soils do, however, resist in varying degrees, the entrance of water because the cohesion developed by the presence of the first small quantity of water as just described tends to hold the particles tightly together. The interstices present in this condition are so small and the rate of infiltration so reduced that the mass is nearly sealed against additional water until some puddling or manipulation multiplies the contacts and disturbs the set of the particles with the resulting entrance of sufficient water to produce plasticity.

The silts range in particle size from .05 to .005 m.m. in diameter. The surface area is consequently much less than that of clay. Based on maximum size, the ratio would be about one to one-thousand.

Silts are not cohesive as compared to clays because the contacts between particles are reduced in proportion to the surface area and the surface tension effect of absorbed moisture is lessened almost to the vanishing point. At the same time the particles are still not sufficient in size to offer much resistence to sliding one over the other and very little internal friction is developed, although considerably more than is the case with clays. The combined effect of low cohesion and low internal friction results in a less stable soil than either the clay or the sandy soil.

Due to the relatively large sized pore spaces present in the silt soil, water percolates readily and is also drawn up to a very great degree of capillary attraction, whereas the reverse is true in the case of clays.

Silts, due to lack of cohesion, do not become plastic in the presence of water and consequently when confined are relatively stable. They erode or wash easily due to porosity and lack of cohesion. Needing cohesion, they benefit by the addition of a ductile base oil in addition to the water-proofing furnished.

Sandy soils are made up of particles ranging in size from 2 m.m. to .05 m.m. in diameter. They entirely lack cohesion, but due to the size and varying with the angularity and roughness of the particles, internal friction is developed to a high degree.

Soils of this type are relatively effective in supporting leads, if confined. If unconfined, they may have very low supporting properties and are very easily eroded. As in the case of silts, the cohesion furnished by a ductile base oil is an advantage.

All degrees of mixtures of these three general soil types are possible, their properties being the resultant properties of the mixtures.

Continuing with our discussion of results, our next conclusion is that the character of the surface immediately prior to the application of the oil is of major importance. Surfaces to which oil is to be applied should be fairly free of dust and should have the pores open to receive the oil. Final preparation of the surface for treating should consist of blading to eliminate all dust, crust and depressions of the road surface rather than the movement of loosened material to obtain uniform cross-sections. A uniformly smooth surface to insure uniform distribution of traffic over the entire roadway is essential for the proper development of the surface.

If satisfactory surface drainage has been provided, so that water will not stay on the surface and be forced into and through the oil surface by the action of traffic, the next important requisite to the successful oil treatment of earth is the proper condition of the surface as regards moisture content. For a successful oil treatment it is necessary that the oil penetrate and become intimately mixed with all soil particles by the kneading action of traffic. The mere presence of the proper quantity of oil on or near the surface is not sufficient. All particles must be coated or saturated with oil. The condition of the soil must be such that the oil can enter and mix with all the particles, either by direct penetration or by manipulation and kneading under traffic. The presence of the normal moisture content promotes the condition just stated in that the moisture keeps open the pore spaces and facilitates the uniform distribution of the oil. By its gradual recession or elimination, the

moisture promotes uniformity and completeness of the contact of the oil with all particles even though the rate of penetration is retarded to some extent. The character of surface prior to oiling, as previously suggested, is in a very large measure dependent upon the moisture content. The presence of dust is due to lack of moisture. Most clays exhibit considerable volume change with variations of moisture content. On drying, excessive shrinkage taken place, resulting in the formation of shrinkage cracks and a hardened crust separated into block by the cracks. This condition is referred to as "hard and crusted" under surface condition survey ratings. The crust has become densified and hardened, and the particles which, in a moist condition were separated by films of moisture, are now drawn into more intimate contact through the stresses exerted by capillary pressure as the water is eliminated. The major portion of the area of the surface is too dense and hard to receive the oil and as a result it enters the cracks between the surface blocks to remain in concentrated form or to distribute itself in the more moist and consequently more receptive underlayers. The blocks of hardened surface receive some oil by penetration around their surfaces, but exhibit a dry and barren interior. If the blocks of crust are not too hard, the kneading of traffic may tend to remedy the condition by helping to redistribute the oil present in the cracks, but under extreme conditions the blocks remain hard and unreceptive. The impact of traffic often causes the surface-coated but unpenetrated blocks to be displaced, starting the familiar condition of raveling and potholing.

Lack of moisture, in the case of soils which have lower volume change with loss of moisture, such as the silts or sandy soils, is not so serious, as the pores vacated by moisture are occupied to a considerable extent by air and are open to the entrance of oil. Dust forms rapidly, however, on this type of soil. If this dust is not penetrated so thoroughly as to bind it to the underlying soil, it will cause serious peeling and raveling, and barren spots, insulated by dust layers against penetration, will later pit and rut or ravel.

Owing to weather and traffic conditions, the surface to be treated can be maintained in the ideal condition for the reception of oil for only a very short period of time, usually not more than 24 hours.

Of sections included in our studies, the best results were obtained on these sections which were bladed the same day the oil was applied. Blading at this time cut down to the zone of normal moisture content and the treatment followed before the moisture had receded from the exposed surface.

Weather conditions are a factor to the extent that they may influence the moisure content of the surface, the rate of penetration and the quality of oil, if loss occurs due to rainfall immediately following application.

With the ranges observed in our experience, there does not seem to be any significant effect of air temperature except as they might serve to speed or retard changes in the moisture content of the soil.

Contrary to general expectation, there is no apparent benefit to be gained by raising the temperature of the oil above that required for uniform distribution. Increasing the temperature of the oil only increases the tendency to flow along or from the surface due to decrease in viscosity, and is detrimental rather than beneficial.

A retarded rate of penetration tends to improve the uniformity of distribution of the oil, thereby promoting the intimate mixture of oil and soil particles desired. Nonuniform penetration which usually accompanies a rapid rate of penetration fails to produce the results desired.

The presence of untreated earth surfaces adjacent to oiled earth surfaces reduces to a varying extent the effectiveness of the oiled surfaces particularly if the untreated surfaces are manipulated, as the untreated earth and dust tend to adulterate and deaden the treated surface. All surfaces, if possible, should be oiled full width.

A development of considerable importance, although it does not have an important effect upon the efficiency of the oiled earth surface as a traffic way, was brought out by observation in connection with these untreated widths in comparison with the treating of full widths. This development was the great efficiency of oil treatments as a means of stopping washing or erosion of soils of the noncohesive type such as those derived from silts. In certain areas, the highway department was faced with the necessity of purchasing additional widths of right-of-way to obtain earth for replacement of earth shoulders removed by erosion. Oil treatment of shoulders immediately and effectively stopped this erosion, saving many dollars in maintenance cost. In extreme cases such simple treatments enabled the holding of fills subject to overflow, which previously and periodically had been lost. After oil treatment, these fills resisted action by virtue of the thin stabilized layer which prevented the inception of washing and crumbling. This development leads us to include the factor of conservation of material in our future considerations for rating effectiveness of oil treatment.

Nonmutilative traffic, as previously suggested, is highly beneficial to oiled earth surfaces, as such traffic tends to knead the oil into intimate contact with the soil particles. This intimate association is a primary requisite for successful treatment of earth with oil. There are strong indications that the serviceable life of the treated road is materially shortened if traffic during the first month after application is not sufficient to furnish the desired kneading action to thoroughly incorporate the oil into the surface. Oiled sections, that have been closed to traffic on account of other construction activities at each end, show extensive dusting in one to two months after application, the oil turning a light brown in color and being dead in appearance, almost entirely devoid of binding properties. The same tendency is almost always exhibited on traffic lanes which, due to excessive roughness, are avoided by traffic early in their life. The traveled lanes will remain in good condition and the balance of the surface will dust and ravel extensively.

Mutilative traffic, such as herds of cattle, lug wheeled tractors, etc., seriously impairs the service rendered where encountered. This traffic, fortunately, is generally localized. During the winter and early spring, the surface is lease resistant to mutilation by traffic and any reasonable and practical means of mitigating this effect will justify some expenditure. In some cases, cover material consisting of a thin layer of clean river sand has been applied with beneficial results. An excess, however, must be avoided unless succeeding applications are made to build up an appreciable mat.

Dragging or blading of a good oiled earth surface is generally harmful. When reshaping is necessary, a retreatment should be given to restore the oiled surface.

Maintenance Methods.—A road that is to be reoiled is usually gone over by the Killefer disk prior to the application of oil. This machine consists of four sets of steel disks set at a slight angle to the center-line of

the road so that the weight rests on the disks. The disks turn as the machine proceeds, resulting in a row of narrow longitudinal cuts produced by shear. This action does not produce or permit progressive skinning or pealing. The axles on which the disks are mounted can be raised or lowered as may be necessary to make more shallow or deeper cuts in the surface. Those not familiar with this piece of equipment will be interested to find that it furnishes a very efficient method for smoothing out almost any type of bituminous surface.

The Killefer disk is followed immediately by a multiple blade maintainer which mixes the loosened material and moves it to any depressions. A motor grader follows this machine and finishes the smoothing and leveling process. Thus with one passage, the humps are removed, the depressions are filled and the entire surface is smoothed. The loose material will rebind with the surface if reoiling follows this operation within a reasonable length of time. Most of the fine shavings will, however, be blown or washed away or lashed off the roadway by traffic if much time elapses between the smoothing operation and the application of the oil.

Surface defects of limited area are, when necessary, maintained by patching. A mixture of earth and the type of oil used in the original oiling are used for filling material. The hole to be filled is cleaned of all loose and foreign material and the patching material is tamped in and given to traffic.

The successful patching of a surface of this kind seems to be largely dependent upon the curing of the patching material prior to use. Mixtures made by hand can be stockpiled for long periods. Another method for obtaining patching material in a cured condition, with a minimum of effort, is by digging a pit to a depth at which soil containing the normal amount of moisture is reached. This pit can be filled with oil and nature does the work. When patching material is desired, it is readily obtained by digging from the pit and is available the year round because it never freezes.

Extensive defects may be successfully patched, if desired, by excavating to a depth of about 6 in. and filling with a mixture of chat and asphalt cut-back with kerosene, following with a light covering of dry earth.

Acknowledgement.—The foregoing is an abstract of a paper presented Jan. 14 at the annual meeting of The Association of Asphalt Paving Technologists.

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How California Cares for Roadside Trees

Since 1920, civic or other public bodies of California have planted nearly 700 miles of highway roadsides to trees. This represents nearly 70,000 trees. In addition, there were about 60,000 older trees which had been planted by tree lovers, making a total of 130,000 trees to be cared for by the maintenance forces of the State Division of Highways. The practice in regard to these trees is outlined as follows in the December issue of *California Highways and Public Works.*

The initial expense of planting and maintenance during the first year is borne by the parties interested. At the end of this period the state assumes their entire care, and replacement in event of loss.

The extent of this responsibility is appreciated when it is known that some $71,500 was expended during the past year for the care and replacement of the plantings, a sum representing 1.3 per cent of the total annual maintenance allotment.

Generally the trees are spaced at 50-ft. intervals, being placed alternately on the right and left sides of the roadway, with necessary elimination for visibility at crossings and road intersections. The care of these trees is very exacting and is usually assigned to the individual foreman in whose territory they occur. Assisting in the direction of this work is the arboriculturist, reporting to the maintenance engineer.

Special tree watering equipment having a movable discharge pipe enables watering to be done from the driver's seat, a tank truck of 1200 gal. usually being sufficient to water some 30 to 40 trees. This watering must be performed every four to six weeks during the period from June to October. Aside from irrigation and cultivation many precautions are necessary for the protection of young trees against insect pests, damage by squirrels, gophers, moles and loose stock driven along the highway. The hazard of fire is also great.

Particular attention is given the location of plantings to eliminate any possible interference with the ultimate development of the pavement. With this in mind, new plantings are discouraged on rights of way less than 80 ft. wide. On 80-ft. rights of way the trees are planted between the curb and right of way line, 31 ft. out from the pavement center.

All roadside trees are inspected at intervals and particular note made of any trees within reach of the traveled way that are in any way a menace. Wherever hazard exists the trees are either removed, or trimmed and dangerous limbs cabled back to insure safety.

As load clearances require a clear height of 13½ ft. above the pavement, systematic pruning and trimming are being followed to provide this clearance and at the same time develop a symmetrical, worth while tree. Where power or telephone lines occur within rights of ways planted to trees, the tree height is limited to 40 ft. and all trimming for wire clearance is done by the utility company under permit and inspection of the Division of Highways.

In addition to the care of trees, the Division of Highways organization is planting shrubs and vines on cuts and fills, particularly at subways and similar structures. In many cases, this work will reduce the upkeep cost at such locations.

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Sand and Gravel Production in 1930

The total production of sand and gravel reported by producers in the United States for 1930, according to statistics made available by the United States Bureau of Mines, Department of Commerce, amounted to 197,501,726 short tons, valued at $115,176,543, a decrease of 11 per cent in quantity and 13 per cent in value in comparison with 1929. There were decreases in quantity and value for the total output of all classes of sand and gravel except paving gravel, the output of that material showing an increase of 7 per cent in quantity though the total value decreased 3 per cent, as compared with 1929.

New York and Illinois, with outputs of 20,865,866 and 17,398,693 short tons, respectively, were the largest producers of sand and gravel in 1930. Other states producing more than 11,000,000 tons each were as follows, in order of quantity produced: Ohio, California, Michigan and Pennsylvania. New York and Pennsylvania led the states in total value of production in 1930.

About 74 per cent of the total output of sand and gravel was reported as washed and screened in 1930.

Road Builders' Convention and Road Show in Retrospect

Motor Transport Units and Accessories and Low Cost Road Materials and Equipment Predominated

ANOTHER annual convention and road show of the American Road Builders' Association has become history. This convention and show was particularly noteworthy, because of the absence of heavy construction equipment, because of the general economic condition of the country, and because of the characteristic trends noted at the show. It could be fairly stated that the convention sessions this year produced better material and information than has ever been presented at previous sessions. The papers and reports showed careful preparation.

The two predominating characteristics of the show were the truck and transport exhibits and the low cost road materials and equipment exhibits. Types of newly developed bituminous products and plants for preparing mixtures were shown along with products of standard recognition. To the engineer the exhibits of the various state highway departments and the Bureau of Public Roads were valuable. Various natural laws as they apply to highway work were presented in pictorial and model form. These engineering data were so clearly presented that one could hardly fail to grasp the ideas that were on display. Were one to shut the glamour of the show from his mind, and study all of the exhibits on the floor, from the technical and scientific point of view, he would develop a fair education in highway engineering and administration.

One thing, however, was disappointing to the attendance. The "inquiring reporter" asked several engineers and contractors if they were disappointed or not in any way with the show, or if they felt they had gotten value received from their attendance. In all cases the replies indicated that they had hoped to see "such and such" equipment. Since it was not there that indicated disappointment. In every case the equipment referred to was heavy construction machinery. It is hoped that a plan can be worked out whereby road construction and maintenance heavy equipment manufacturers can find it feasible to display their equipment.

It would be a difficult matter to judge between the various exhibits as to which one would take a prize were such a prize established. A dozen contend for first place in the judgment of a dozen different individuals. Some of the exhibits were prepared from an educational standpoint, others from a showy standpoint, others from a catchy point of view, etc. Complaint was heard among some of the exhibitors regarding prices they were compelled to pay for certain services. It seems that so far, at each show, there has been some service required by exhibitors for which they have been gouged. This should be placed under control.

No doubt the stressed business condition of the country caused this show to be smaller than others of the past. Less equipment was displayed and more models were employed. Even though general business is greatly below normal, highway expenditures, while off some, are going to be a bolstering column for manufacturers serving this field. This fact should be recognized and preparations should start now, amongst manufacturers, for a bigger and better display in 1933.

Convention Sessions.—Because of the rapid strides made in the past year or two in the art of highway betterment, papers and reports prepared and presented at the various sessions were all of informative character. Many projects and projected theories took definite form in this period. Trends became more defined. The Association of Asphalt Paving Technologists held, for the first time, their annual meeting in conjunction with the convention sessions of the Road Builders' Association. This was an opportune move because it allowed those interested in bituminous road work, and the use of bituminous materials in low cost road work to get first hand technical information on their problems. The biggest advantage, of course, of conventions is the opportunity offered for one to get the friendly personal contact of others in the industry who are working on similar problems. Perhaps greater benefits accrue to those in attendance in their personal, individual conversations than from the regular convention reports. The convention sessions are the common meeting ground for the leaders in the industry and it is at these sessions where advanced ideas, and reports of research are announced and discussed. All reports and papers are prepared ahead of time by the various committees and this year's procedure was given the added advantage of having staff engineers of the Road Builders' Association act as secretaries to prepare the reports. This excellent procedure is commendable from several viewpoints. The principal advantage, however, lies in the fact that one man devotes his time and ability to collecting and digesting all available information on the subject.

Transportation.—The show and convention was held at the municipal airport at Detroit. The arrangement was admirably suited for the occasion except that it was so far from the hotels in town. Considerable credit is due, however, to the man in direct charge of transportation. He had buses going and coming every few minutes that made stops at all of the leading hotels. This greatly relieved the inconvenience of the distance involved, yet twenty minutes to a half hour was usually lost in transportation each way. A nominal fare was charged which, in these times, was less, relatively, than one would expect to pay for traveling that distance. The taxicab drivers had to be watched for they would not hesitate to charge according to the meter even though a flat rate was advertised. Taken as a whole, the writer was favorably impressed with the transportation management.

How Highway Lighting
Increases Safety of Night Driving

By DUDLEY M. DIGGS
Member Rural Hazards Committee, National Safety Council

THE highways are built to handle traffic. This traffic may be divided into two main divisions—traffic by day and traffic by night. I wish to write of the traffic by night. I wish to tell you how it can be made safer—how it can be made more comfortable—how it can increase the use of the roads at a time when they are little used—how it can relieve congestion at the time relief is most needed—how it can increase the capacity of existing roads. In a word, I wish to talk to you about highway lighting.

Motor Vehicle Accidents Cost $900,000,000.—First and most important are accidents. Of such vital importance is the appalling economic loss from accidents that practically every state keeps detailed statistics of them. The summation of these shows that the cost of motor vehicle accidents in the United States during 1928 was approximately $900,000,000. One of the facts in connection with this is that a greater and greater proportion of these accidents are continually shifting from city streets to rural highways.

Attention is called to the fact that the general trend of increased accidents is typical in most of our states, —most notably Pennsylvania, Connecticut, Massachusetts, and New York. Regarding typical statistics, I would like to call your attention to the fact that these were obtained from the New York Motor Vehicle Bureau at Albany and cover the state of New York. May I call to your attention two startling figures from the accident statistics.

Day accidents, 1927	41,502
Day accidents, 1930	55,683

Increase in day accidents of approximately 36 per cent in 3 years.

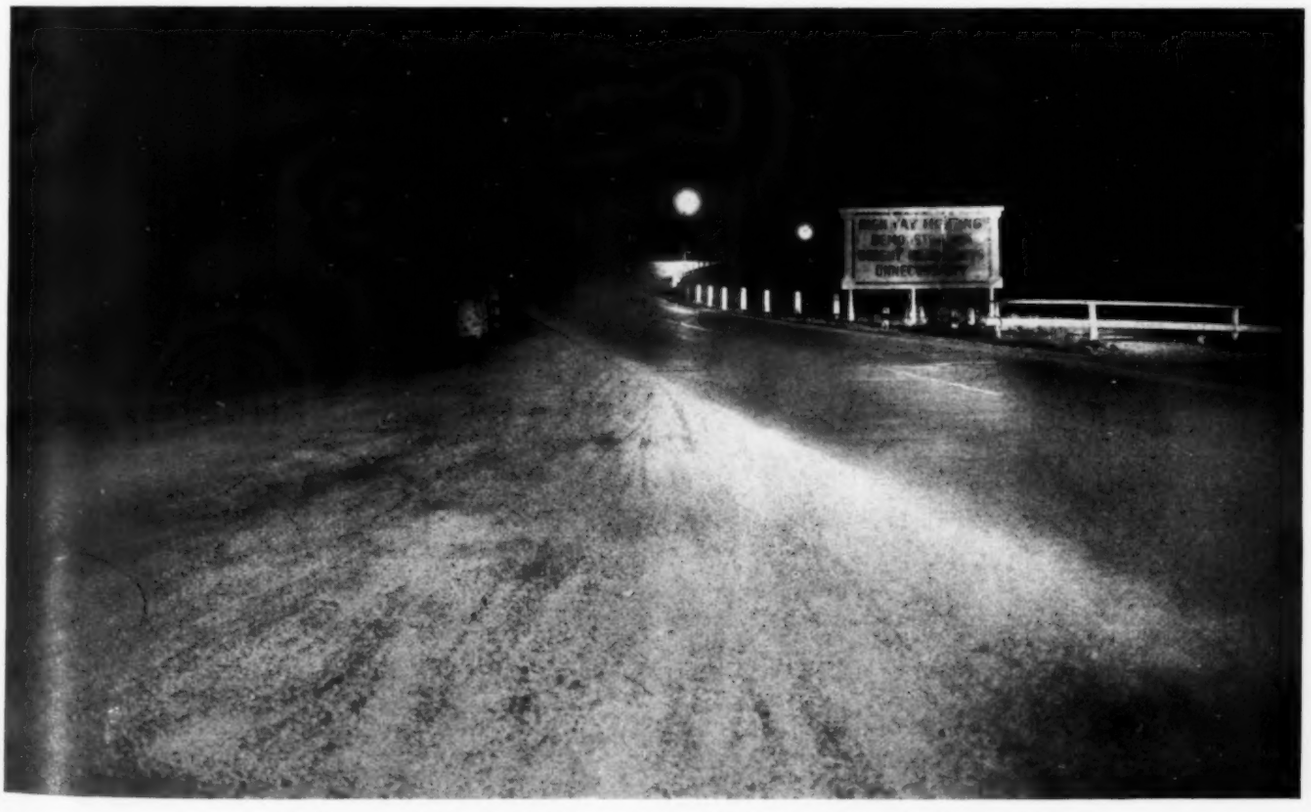
Now let us turn the page and look at the night picture.

Night accidents, 1927	29,724
Night accidents, 1930	41,601

This shows an increase of approximately 40 per cent in 3 years. In other words the night accidents are going up at a faster rate than the day accidents.

Fatality Rate for Night Accidents Increases.—From these same statistics, we find that the rate of fatalities or deaths from automobile accidents during the daytime has decreased slightly in the last three years. During the same period, however, the rate of fatalities or number of people killed at night has increased. This shows conclusively that the hazard of night driving is increasing at a faster ratio than the hazard of day driving.

Now let us ask ourselves the question, where they are increasing the fastest. A similar analysis shows accidents on the rural highways going up at a faster rate than any other place. Let us therefore analyze the rural night accident figures for New York for 1930.



Highway Lighting Installation on Schenectady-Amsterdam, N. Y., Road

Installation on Owasco Lake Road, Auburn, N. Y.

It is estimated by the National Safety Council that at least 35 per cent of night accidents are due to insufficient or improper illumination. Let us assume that approximately one-half of these occur on the highways after dark. On the basis of collecting statistics, each accident results in an average economic loss of approximately $1,000. An automobile accident at night would be well above the average, so that we would be most conservative in using this figure. You can, therefore, readily calculate the total economic loss. The following gives this for New York State for 1930.

Accidents which occurred after dusk	41,601
Persons killed in accidents after dusk	1,486
Number of accidents after dark on highways using inadequate and insufficiently illuminated (estimated)	7,000
Total economic loss, State of New York for the year 193, due to accidents caused by inadequate and improper illumination of highways	$7,000,000

The increase in night accidents is going up at a much more rapid rate than the total increase in accidents. Loss of human life cannot be estimated in dollars and cents. If we could save only 100 lives a year on our main highways (the place where most of the accidents occur) it would be more than worth while. Individual cases of accidents, or near accidents, due to inadequate or no lighting on the highways could be given almost without number. The percentage of fatal accidents involving pedestrians is so high that I wish to mention some recent tests in regard to this:

Visibility of Pedestrians.—These tests prove that pedestrians in dark clothing are not sufficiently illuminated by automobile headlights to allow them to walk safely on a dark surfaced highway. The pedestrian almost invariably fails to realize this, he thinks a bright headlight shining towards him makes him easily visible. Under many conditions he is seen with difficulty and barely in time unless dressed partly in light clothing. His visibility depends largely on the amount of reflected light from his clothing. When dark clothing is worn it absorbs practically all the light directed on him from the headlights. He is, therefore, almost invisible.

What One Improvement Association Has Done.—That this problem is being tackled practically and successfully can be illustrated by the accomplishment of one Improvement Association in New York State—the Mohawk Valley Towns Association.

The object of the association is the improvement and beautification of the Mohawk Valley, and it has many projects on its program. Chief among them is the lighting of the main route through this historic and beautiful valley. The stretch lying within the territory of this Association runs all the way from Schenectady to Rome, a distance of 100 miles. Through the fine cooperation of the board of supervisors in the counties interested, over 20 miles of highway lighting are now being installed.

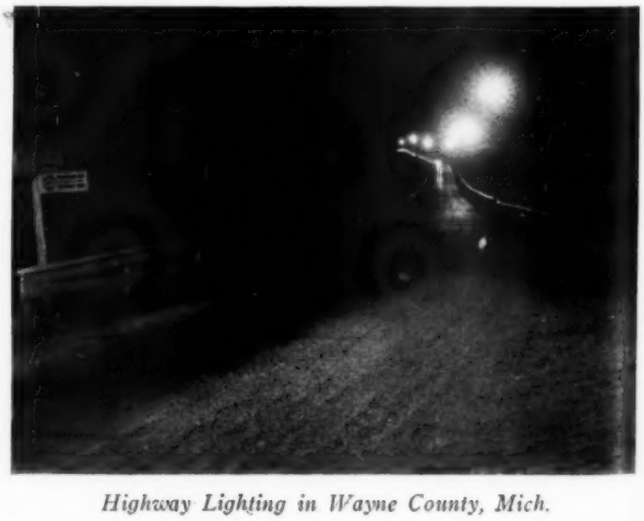
Within five years it is hoped that the entire 100 miles will be lighted so that it can be traveled at night with ease, comfort and safety. Think of starting from Albany, proceeding all the way to Schenectady, through Schenectady to Amsterdam, through Amsterdam to Utica, Utica to Rome—all the way with a thoroughly up-to-date modern highway lighting system. What a relief and what a pleasure!

When the Mohawk Valley Towns Association decided on this project they secured the cooperation of the automobile clubs, boards of supervisors and city officials. Together they investigated its practicability, the advantages to be derived, and its cost. Most of the installations already in existence were not good enough to produce the results demanded, so the cooperation of the manufacturers and power companies was secured. A mile of road was selected—not for the ease with which it could be lighted, but for the difficulties which it presented. The whole stretch was of black non-reflecting surface, two hills, two curves, a railroad on one side and on the other side alternating roads, fields and river. Midway was an intersecting road and a bridge, joining the main road at right angles. At one end was an overhead pass with steep approaches and a right angle bend at each end of the bridge.

The lighting of this mile of road was studied until the results were proclaimed satisfactory by city, county and state officials, illuminating engineers, power company officials, laymen, keen observing newspaper reporters and others. Many things were considered, but chief among them was safety—safety to the pedestrian as well as the motorist. This commercial mile of highway with its day in and day out traffic, sometimes a dry road surface, sometimes wet, foggy nights, clear nights, moonlight nights, dark nights, stormy nights, snow, sleet, rain—all were studied.

It would be impossible to tell you all the conditions and angles. To know that one of the officials of a chamber of commerce drove through this lighted zone six times a week for many months will serve to indicate the thoroughness of the observations.

In addition to the above mile the department of public safety made available a street on which more danger-



Highway Lighting in Wayne County, Mich.

ous tests could be conducted. A police officer was stationed at each end to divert traffic while the tests were in operation. Here the difficulty of revealing dark objects on a dark road surface, the danger to pedestrians, and other studies were made with greater thoroughness than could be done on a highway carrying traffic.

Advantages from a Well-Lighted Highway.—We have seen the practical and scientific way the tests and investigations were carried through. Let us now review the advantages to be derived from a well-lighted highway. There are many, chief among them being:

1. Increase in safety of highway by preventing accidents, hold-ups, vandalism.
2. Much greater safety in night driving.
3. Additional comfort in night driving.
4. Faster, but safe, night traffic.
5. Enhanced real estate values.
6. Increased road capacity.
7. Electricity rendered more readily available to farmers.

Now just how are these advantages accomplished?

By spreading traffic equally over the 24 hours.

At present the big majority of the traffic is during the daylight hours. This traffic could be relieved during the day by diverting it to the night hours. If the highways were lighted there would be a greater incentive to do more and more trucking by night. Repairs could be made more easily, tires changed, etc. Night speeds could be safely increased, resulting in more cars per mile throughout the 24 hours.

Pleasure and commercial salesmen's automobiles would use the road more at night thus decreasing the day travel by that amount and adding it to the evening traveling. Many times the saving of a few hours means the saving of a day—the difference between an immediate unloading and a wait of possibly twelve hours. In the winter when darkness comes on so early, a lighted highway would allow the saving of this time and thus increase the effective running time of commercial vehicles.

By having the pole lines for the highway lighting, the power becomes more readily accessible to the farmer—a most important item—as the farmer, if he expects to survive, must depend more and more on electricity to relieve him of the manual labor the same as it has done in factories and cities.

By minimizing headlight glare, thus making it feasible to drive with the lower or depressed beams of their headlights.

By showing up holes and obstacles in the road.

At night you have probably noticed how headlights cast dark shadows on irregular road surfaces. These shadows obscure the irregularities and make it impossible to gauge their depth and width. If the lights were directed from above, the irregularities would be shown in their correct perspective.

By illuminating the sides of the road.

By illuminating pedestrians.

This is a very important point as a large percentage of the accidents are between pedestrians and autos (in one state over 60 per cent). It is mostly between dusk and dawn that these occur.

Proper highway lighting is the solution of some of the most vexing highway problems of today. It solves the problems, it gives many, many advantages at a cost that is exceedingly small. In the case previously referred to the whose cost, including installation, maintenance, and current being less than 3 per cent of the initial cost of the road.

Diverting the Gas Tax

There is an increasing tendency to divert the receipts from gas taxes and motor vehicle license fees to purposes other than highway construction and maintenance. Here is what the *Herald and Examiner* of Los Angeles, Calif., thinks of the practice.

"For some time it has been evident that the heavy expense program of the state is fast developing a deficit. To make increasing expenditures and decreasing revenues match each other is the great problem of state officials just now.

"For this reason a vicious proposition has been advanced—no less than that of taking from the receipts of the gasoline tax some $8,800,000, and from the truck and bus franchise taxes about $1,500,000, and apply these funds to general purposes.

"In other words, it is proposed to repudiate the pledge made to the taxpayers that these extraordinary levies would be held sacred for highway uses, and by that repudiation penalize the motoring public for the benefit of enterprises now being rightfully financed by general taxation.

"The fact might just as well be faced that if this diversion is allowed to be made, it will be but the beginning of endless drains upon the buyers of gasoline, thus constituting a serious detriment to the efforts and plans for constructing and maintaining an adequate highway system.

"Permit this grab, and the door will be opened wide for other diversions in the future, not only by the state, but also by county and municipal governments which may find themselves faced with the necessity of retrenchment or the discovery of new sources of income.

"When the gasoline tax was increased from two to three cents per gallon, the motorists made little protest, because of the assurance that the money would be used for extending and improving the state highway system until such time as every community in the state is connected with every other community by improved highways. That has not yet been done. In time it will be, but for the present every dollar of gasoline tax money is needed for the purpose for which it is levied.

"There is no surplus in this highway development fund. What at times may appear to be a surplus is merely an accumulation of funds which are urgently needed and whose disposition only awaits the working out of new construction and improvement plans.

"As to the state highway bonds, voted before there was a gasoline tax, the interest and principle of which it is sought to pay from gasoline tax moneys, such bonds represent no more than the rightful investment the citizenship of California should make for its roads.

"It is but fair that this investment should come from general tax receipts. It would be most unfair to divert a special tax, intended and pledged for a specific purpose to the uses of the state's routine expenses.

"In 1930 the registration fees and gasoline taxes amounted to more than $35,500,000. Thus it will be seen that owners of motor vehicles are paying the entire cost of present state highway maintenance, improvement and construction—exclusive of federal aid—and in addition a substantial portion of similar costs for the county highways.

"It behooves every citizen to take notice of the danger which threatens our state road system by the advocacy of this diversion proposal. It should, moreover, be the aim of every California taxpayer to oppose to the utmost every confiscation of highway taxes for any other purpose whatsoever."

Connecticut Roadside Beautification

BEFORE

Showing a barren roadside condition on Route 112 outside of Middletown, Connecticut. Spots such as these grow luxuriant native weeds that are as much of an eyesore as the pole line that parallels the right of way

AFTER

With a little expert treatment the weeds are replaced by a grassy area containing juniper and other low growing shrubs. The pole line, now, sticks out like a sore thumb; the only blot on an otherwise pleasing vista

Pictures by Courtesy of Mr. Luther M. Keith, Connecticut State Highway Tree Warden

Water Curing

Costs

For Concrete Pavements

By Various Methods

RECENTLY published tests* show the effect of water curing and other methods of curing concrete pavements. The tests indicate that proper water curing not only seems to produce concrete of the requisite high strength, but also prevents early shrinkage and consequent frequent transverse cracks. Surface hardness, as evidenced by resistance to wear, is increased by water curing.

Tests by the U. S. Bureau of Public Roads indicate that when the atmosphere is very dry, unprotected concrete may lose as much as 35 per cent of the total mixing water during the first 5 hours after it is placed. With a relative humidity of 64 the loss was 16 per cent in the same time.

The average increase in strength for water curing, as compared with no curing, for field conditions is one-third.

All these considerations make water curing desirable. The different methods and costs of water curing are summarized on the following pages:

Water

Based on 10-mile job, 10-hour day, 100 paving days per season: (From Illinois Association of Highway and Municipal Contractors' Convention of 1927.)

Estimated Equipment

1 Pump	$1,200.00
1 Mi. 3 in. pipe and fittings	1,900.00
2 Mi. 2 in. pipe and fittings	1,800.00
Total	$4,900.00

Equipment Expense

Small tools	$ 24.00
Fuel at $4.00 day, 125 days	500.00
Repairs, 10 per cent	490.00
Depreciation, 25 per cent	1,225.00
Interest, 3¼ per cent	184.00
Freight	150.00
Total	$2,573.00
Charge ½ to curing	$1,286.50
400 ft. ¾ in. hose	76.50
Total Equipment	$1,383.00
Equipment expense for curing per sq. yd.	.0131

Labor

Loading, unloading, hauling and distributing pipe:

1 Team and wagon at	$ 6.00
2 Men	8.00
	$14.00 per mi.
$14.00 x 2¾ mi. x 5 (operations) per 10 mi.	192.50
Coupling and uncoupling (4 operations) 3 men at $12.00 at 2 days per mi. $12.00 x 2 x 2.5 x 4	240.00
Hauling pump 3 times, 1 day total (2 set-ups)	6.00
Setting up pump twice 3 men 1 day total	12.00
Pumpman at 50c per hr. for 12 hr. day, 125 days	750.00
Workmen's compensation	36.00
Total all water	$1,236.50
½ for curing	$ 618.25
Labor expense for curing, per sq. yd.	$ .00585

Grand Total

Equipment, per sq. yd.	$ .0131
Labor, per sq. yd.	.00585
Total (No allowance made for overhead)	$ .01895

Estimating 3,500 gal. for curing 100 lin. ft. of 18-ft. pavement, or 200 sq. yds., it will take 17½ gal. per sq. yd. Hence, the cost will be $\frac{.01895}{17.5} = \$.00108$ per gal. or $0.0081, per cu. ft.

Burlap Curing.—Wet burlap is customarily used for preliminary water curing. Burlap ranging in weight from 10 to 18 ounces is used, 12 ounces being the most common weight. In at least three states two thicknesses of burlap are required. The 6 to 8 ounce weight is customarily used where a double thickness is specified.

Curing by Spray Method in Seattle, King County, Washington

Public Roads, Jan., 1931; Tests by Tennessee Department of Highways in cooperation with the U. S. Bureau of Public Roads.

Curing tests in Tennessee indicate that 72 hours of wet burlap curing is nearly as effective as the customary 10 or 12 days of wet earth, and better than any of the other substitutes for wet earth curing. Consequently, Tennessee and possibly other states will cure pavements for 72 hours with wet burlap and omit further curing.

The burlap is laid on the slab as soon as the concrete has stiffened sufficiently to support the weight without marring. It should be put on wet, as dry burlap acts like a wick, taking moisture out of the pavement. The strips of burlap are commonly three feet wide, but may be much wider, and are about two feet longer than the width of the slab being cured. It is convenient to have a platform 6 or 8 feet wide and as long as the width of the slab, supported on four wheels that ride on the forms.

Burlap to be sprinkled is piled on this platform and strips are lifted from it when the slab is being covered. When the burlap is removed before removal of the side forms this platform is also used in gathering up the burlap and for carrying it forward. But when the forms are removed first the burlap is carried forward by wagons, on industrial railway cars, or by workmen.

The cost of burlap curing depends upon the length of the curing period. For a 24-hour period and an average run of 1,000 lin. ft. of 18-ft. slab per day, about 2,100 sq. yds. of burlap are required, costing, for the 12 ounce weight, $210. This is entirely depreciated at the end of an average construction season of 120 days, making the cost $1.75 per day or $.000875 per sq. yd.

Removing and spreading burlap and covering edges with earth will take the time of two men, or a total of 20 hours at 40 ct. per hour, making $8 per day, or $.004 per sq. yd.

Sprinkling takes the entire time of one man for each 1,000 ft. of covered slab, or 10 hours at 35 ct., making $3.50 per day, or $.00175 per sq. yd.

The water needed depends upon temperature, humidity, with velocity, and elevation but an average of 1½ cu. ft. per minute for 8 hours each day may be estimated, or 0.36 cu. ft. per sq. yd. At $0.0081 per cu. ft. the water for 24-hour burlap curing would cost $.00292 per sq. yd.

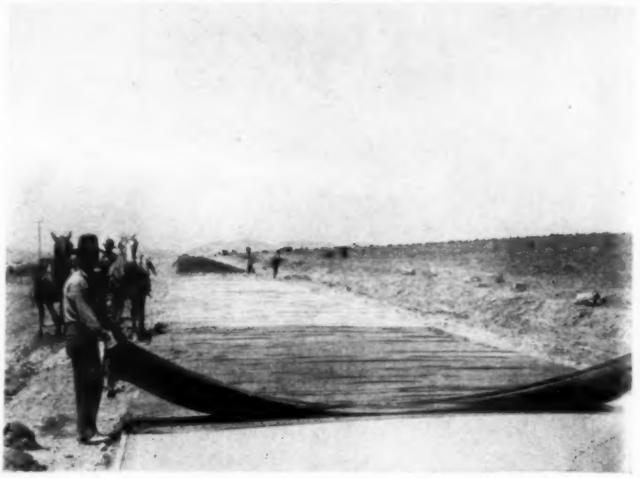
BURLAP CURING
Total Cost 24 Hours

Items	Per Day	Per Sq. Yd.
Burlap	$1.75	$0.000875
Water		0.00292
Labor	11.50	0.00575
Total		$0.009545

For 72 hours of burlap curing three times as much burlap is required and, since it is exposure to moisture and the weather that deteriorates it, it will be completely depreciated at the end of one 120-day construction season, making the cost three times that of 24-hour burlap curing, or $5.25 per day, and $0.002625 per sq. yd.

Labor of removing and replacing it is the same or $8 per day, except that one team will be needed during removal, i.e., 2 hours per day at 60 cts. or $1.20. Three men are required for sprinkling, each handling 1,000 ft. of pavement at $3.50 per day each, or $10.50 per day and $0.00525 per sq. yd.

Water required will be three times that used for 24 hours of burlap or $0.00876 per sq. yd.



Preliminary Curing With Wet Burlap near Nephi, Joab County, Utah

BURLAP CURING
Cost of 72-Hour

Items	Per Day	Per Sq. Yd.
Burlap	$ 5.25	$0.002625
Water		0.00876
Labor	15.70	.009850
Total		$0.021235

Spray Curing.—Either a continuous or intermittent spray that keeps the pavement constantly wet has frequently been used successfully, especially for street pavements where water under constant pressure is usually available.

Much of the success of curing by sprinklers depends upon the type of nozzle selected. The nozzle should throw an even, fine spray over the whole area it is supposed to cover. Too heavy a spray wastes water.

With hydrant pressures of 50 to 65 lb. per sq. in., sprinkler nozzles especially built for this service are attached to a 1 to 2-in. pipe line at 20-ft. intervals and will properly cure a slab 25 ft. wide. Where the pavement does not exceed that width, one pipe line down the center is sufficient. Wider slabs are seldom built in one operation but when they are, two pipe lines are used.

When the wind is blowing the nozzles are pointed into the wind to secure even distribution.

With a pressure of 60 lb. per sq. in., a 2-in. pipe line will handle 1,000 ft. of slab.

The pavement is first cured for 24 hours with wet burlap, so that the pipe line can be placed on the slab without marring the concrete.

An automatic valve may be installed at the hydrant which makes the nozzles operate intermittently, resulting in a saving of at least 75 per cent of the water that would be used in continuous operation. The period of flow required depends on the weather but sprinkling one minute in each 10 to 15 minutes is average.

In Denver an automatic sprinkling cost less than half what wet earth or hand sprinkling cost. In Seattle the city water department charges 3 ct. a sq. yd. for water used in curing pavement and the cost of placing and removing the sprinkler line is 2 ct. per sq. yd., making a total of 5 ct. per sq. yd.

In Niles Center, Illinois, where continuous sprinkling was used without the intermittent valve, the quantity of water used was 50,000 gal. for 8 days' curing and

the approximate average cost for pipe line, labor and water was $.038 per sq. yd.

Ponding.—Because of the small quantity of earth that must be placed and removed, ponding is the least expensive of the curing methods employing a constant wet blanket. It can only be used where grades are comparatively flat, a grade of 3 per cent being about the greatest on which it is economical.

Earth dikes are placed along the edges of the slab and at intervals across it, to retain ponds of water which cover the pavement to a depth of an inch or two. The frequency of the transverse dikes depends upon the pavement grade. For flat pavements they are located at transverse joints and where poured joints are being used a dike is put on each side of each joint to prevent escape of water through the unfilled joint.

Usually two men are employed in building and removing the dikes and keeping the ponds filled with water. On appreciable grades it may take three men since many more dikes are needed. The water required depends upon temperature, humidity, velocity of wind, and elevation above sea level. For middle-western states the average evaporation from open shallow ponds during the summer months is about 4½ in.

Ponds of Water Held on the Pavement on a 2 Per Cent Grade by Earth Dikes at W. Frankfort, Franklin County, Illinois

per month and for a 10-day curing period may be taken as 1½ in., so that, if the usual specification that the pavement be covered with water 2 in. deep is complied with, no additional water should be required. Add to this 25 per cent for seepage, making a total of 1.875 cu. ft. per sq. yd. of pavement. With water at $0.0081 per cu. ft., the cost for water is $0.01519 per sq. yd. of pavement.

PONDING CURING

Item	Per Day	Per Sq.Yd.
Water		$0.01519
Labor—2 men	$8.00	0.00400
Total		$0.01919

To the above figure should be added the cost of 24-hour burlap or $0.009545, to get the total cost of curing by ponding, which is $0.028735 per sq. yd.

Earth and Water Curing.—For earth and water curing a 2-in. blanket of earth is spread on the slab following removal of burlap. For an average run of 1,000 ft. per day and average earth 6 men will keep it covered, making the cost $24 per day. A blade grader, operated with one team and driver at $6.00 and one helper at $4.00 with rental for the grader of $6.00 per day, or a total of $16.00 per day, will clean a mile of pavement in half a day, at a cost of $8.00 per mile or $0.000757 per sq. yd. for cleaning.

Since earth cover does not have to be wetted very frequently one man can care for 2,000 lin. ft. of slab or 4,000 sq. yds., working on it daily for 9 days at $3.50 per day, a total of $41.50 or $.007875 per sq. yd.

Water evaporates from earth at about the same rate as from open ponds so the water required for earth curing will be about the same as for ponding, costing $.01519 per sq. yd.

BURLAP AND EARTH CURING

Item	Per Day	Per Sq. Yd.
24 Hours Burlap		$0.009545
Placing Earth	24	0.012000
Removing Earth		0.000757
Wetting Earth		0.007875
Water		0.01519
Total		$0.045367

Note: The total water for curing estimated by the Pennsylvania Highway Department is 4,000 gal. for each 100 ft. of slab. For earth curing or ponding plan plus 24 hours of burlap this estimate shows 3,400 gal. per 100 ft.

Hay or Straw Curing.—In some localities a blanket of hay or straw is preferred to earth curing or ponding because it is easier to remove than earth, holds moisture better, and can be used over again from 3 to 5 or 6 times.

A good rye straw or marsh hay is better than oat or wheat straw or timothy hay, which seem to be so brittle they deteriorate rapidly when handled. A tough grass which retains moisture is best.

Most specifications requires a 6-in. layer of hay or straw. A ton will cover from 300 to 800 sq. yds., depending upon the kind of material used. The cost of straw or hay varies widely with the locality but a rough average of $7.00 per ton delivered will be used, which will be estimated to cover 500 sq. yds. of pavement and be used four times, costing $.0035 per sq. yd. for the hay or straw.

One man at $4.00 per day can cover an average of 1,400 sq. yds. per day and a man and team at $6.00 per day can load and haul the material ahead to the spreader, a total of $10.00 for 1,400 sq. yds., or $0.00715 per sq. yd.

Straw and hay retain moisture better than earth and do not need to be sprinkled so frequently. One man

Curing With Straw Covering Soaked With Water

can keep 5,000 sq. yds. sufficiently damp which, at $3.50 per day for 9 days, is $.0063 per sq. yd.

Water required is four-fifths that for earth or $.01215 per sq. yd.

BURLAP AND STRAW CURING

Item	Per Sq. Yd.
24 hours burlap	$.009545
Straw	.0035
Spreading and removing	.00715
Wetting	.01215
Total	$.032345

SUMMARY—COST OF CURING

Method	Cost Sq. Yd.
24 hours burlap	$0.009545
72 hours burlap	.021235
Spray	.03 to .05
1 day burlep 9 days ponding	.028735
1 day burlap 9 days earth	.045367
1 day burlep 9 days hay or straw	.032345

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Surface Treatment of Timber Bridge Floors

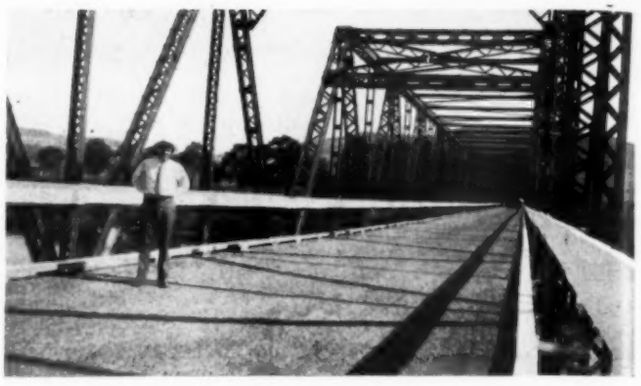
By P. K. SCHUYLER

President, Federal Bridge Company, Washington, D. C.

The wear on the surface of a timber bridge floor is the most important factor in the determination of its life. There are in use various methods of reducing this wear, such as the installation of steel traffic treads, or the covering of the floor with a bituminous mat of one and one-half or two inches in thickness. In an effort to obtain satisfactory results along this line at a minimum of cost, a bituminous surface treatment has been developed which is proving very satisfactory.

The treatment consists in placing a cut-back asphalt or tar on the floor and then applying stone chips to give a body to the treatment. The completed treatment will produce a thin covering about ⅜ of an inch thick. The asphalt or tar is applied hot by means of a distributor. The timber floor should be dry and clean to receive the coating. A light treatment of about 1/6 gal. per sq. yd. is first applied and this upon cooling seals the cracks. Then a second treatment of 1/3 gal. per sq. yd. is applied. Immediately upon placing the second treatment and before it has cooled, stone chips, to the amount of 40 lb. per sq. yd. are spread. This spreading can be satisfactorily accomplished by using a dump truck and causing the truck to dump while backing across the floor, so that the chips are in place before the wheels of the truck pass over the hot material. If this is not done, the wheels of the truck will pick up the bituminous material and an uneven treatment will result. Limestone chips of a maximum size of ¼ in. are used. For a few days after the surface has been laid, any chips that remain loose or are kicked aside by traffic, should be broomed back and spread evenly.

This type of surface treatment has been placed on three bridges, and the one at Harrisburg, Pa., receives heavy traffic. Some bare spots appeared after a year's time, but these were readily patched by hand methods. The surface on this bridge has now been down for a year and a half and is in good shape. The treatment sticks well to the timber floor, even although the flooring is old lumber. The wear is taken off of the planks, and they are protected to a considerable degree from moisture. A rough non-skid riding surface results and the floor is rendered almost noiseless, which latter result is appreciated by nearby residents.



Timber Floor of Smithboro Bridge Treated With Light Bituminous Surface

A surface was placed on the Smithboro, N. Y., toll bridge over the Susquehanna River during the past summer. The floor to be covered consisted of timber that had been down for some five years and was showing considerable wear. It contains an area of 1,480 sq. yds. A study of the cost of this work shows the following:

750 gals. cut back asphalt in place at 12c or ½ gal. per sq. yd.	$ 90.00
16 cu. yds. limestone chips spread at $3.50 or 40 lb. per sq. yd.	56.00
Supervision	50.00
	$196.00

or $.13 per sq. yd.

It is believed that a bituminous surface treatment of the nature described can be used to advantage on numerous bridges now existing with timber floors.

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The Business Executive in Safety Work

A super-committee which will bring a new type of big business executive into active work in the safety movement has just been announced. The new group is to be known as the Special Advisory Committee of the National Safety Council and its members are made up of heads of some of the best known corporations in the country.

Samuel Insull, Jr., of Chicago, will head the committee. It will include the presidents of three railroads: P. E. Crowley of the New York Central; Paul Shoup of the Southern Pacific and F. W. Sargent of the Chicago & Northwestern; the president of the General Electric, Gerard Swope; the president of the Detroit Edison Company, Alexander Dow; the president of the Consumers Company of Chicago, Stuyvesant Peabody; the president of the U. S. Gypsum Company, Sewell Avery; the vice president of the Mellon National Bank in Pittsburgh, Richard K. Mellon, nephew of the Secretary of the Treasury; H. H. Robertson, president of the H. H. Robertson Company, Pittsburgh; Frank J. Lanahan, president, the Fort Pitt Malleable Iron Co., Pittsburgh; Edward Dana, general manager of the Boston Elevated Railway; Robert M. Hutchins, president of the University of Chicago; and Harry B. Earhart, president White Star Refining Co., Ann Arbor.

The new committee is to cooperate with the Executive Committee of the Council in broadening the safety movement in all its aspects.

Modern Street Lighting, I. E. S. Code

By ALEXANDER ANDERSON
New York Power and Light Corporation, Albany, N. Y.

A COMMITTEE of the Illuminating Engineering Society, composed of consulting engineers, utility men, electrical laboratories, manufacturers, street light officials of municipalities, university professors and advisory members, have worked for two years preparing a minimum code for street lighting, which was adopted at the I. E. S. Convention at Richmond in October, 1930. This code was also adopted by the N. E. L. A. as their engineering standard for street lighting. The work of this committee is a splendid thing for everyone concerned, as it standardizes the art for all parts of the country.

Planning.—The importance of street light planning has become a recognized fact, both for the present and future extensions. In the past street lighting has in many cases been haphazard and irregular, no comprehensive plan having been made and established, with the result that a few streets are well lighted and others are not. Planning is now being taken up by cities along modern lines where it has not been already accomplished. The manufacturers have done their part. Equipment for any size city is on the market. It is always well to standardize on the type standards to be used on the different classes of streets; the fewer the number of types used the better, which tends to improve the appearance of the streets.

Progressive communities are taking up the improvement of street lighting by drawing ordinances classifying the streets and specifying the kind of standards, fixtures, lamps and spacing to be used on the several classes of streets.

In drawing an ordinance, the names of all streets in a class should be written in under that class, and a program included of the streets to be improved year by year until completed. Usually a time is set, such as a five-year period, to completely revamp the present system and carry out extensions along the lines laid down in the ordinance.

In drawing up a street lighting improvement program, the engineers will allow for 20th century high speed traffic by specifying the requisite illumination per lin. ft. of street, so that vehicular and pedestrian traffic may move with safety.

The old plan of part lighting after 1:00 A. M. and moonlight ordinances should be done away with. The latter part of the night is the time when the police value good lighting, as criminals usually keep away from bright places.

The following are the principal specifications of the code for street lighting adopted at the convention of the Illuminating Engineering Society at Richmond in October 1930:

Classification of Streets.—For the purposes of the recommendations which follow, thoroughfares, streets and highways may be classified according to their type and traffic functions, as follows:

Light Traffic Thoroughfares—Residence Streets.
Medium Traffic Thoroughfares—Alleys.
Heavy Traffic Thoroughfares—Park Drives.
Business Streets—Highways.

To classify traffic, take the vehicular counts per hour of a typical week at maximum, during lighting period. On this basis the following are considered usable definitions:

Light traffic thoroughfares usually carry a maximum of not more than 500 vehicles per hour, both directions.

Medium traffic thoroughfares usually carry a maximum of approximately 800 to 1200 vehicles per hour, both directions.

Heavy traffic thoroughfares usually carry a maximum of more than 1500 vehicles per hour in both directions.

This code is a minimum for representative conditions; accordingly, as traffic density increases and streets are unusually wide, use more light.

When headlight laws are not enforced, more light is required.

With heavy pedestrian traffic, use more light.

With street car traffic, use more light.

With one way traffic, use less light.

No auto parking calls for less light.

The following are the code minimum recommendations for the different classes of streets:

Light Traffic Thoroughfares.—For light traffic thoroughfares the minimum recommended is a staggered arrangement of lighting units with luminaries located on brackets extending out beyond the curb at a mounting height of not less than 18 ft.; with this mounting height the space should not be greater than 150 ft.; with such mounting height and spacing the lamp rating should not be less than 4000 lumens (400 candles). On narrow thoroughfares (as 25 ft. between curbs) lighting units may be located on one side of the street, although better results will be obtained if the units are staggered. This specification is based upon the use of equipment of the most effective type in the most effective manner. With less effective equipment or less effective application of light, larger lamps or closer spacings are required. The minimum mounting height of 18 ft. should be employed only where trees are present or other conditions make a higher mounting height impracticable. Mounting heights between 20 and 25 ft. are recommended where practicable.

Medium Traffic Thoroughfares.—For medium traffic thoroughfares the minimum recommended is a staggered arrangement of lighting units with luminaries located on brackets extending out beyond the curb at a mounting height of not less than 18 ft.; with this mounting height the spacing should not be greater than 150 ft.; with this mounting height and spacing the lamp rating should not be less than 10,000 lumens (1000 candles). This specification is based upon the use of equipment of the most effective type in the most effective manner. With less effective equipment or less effective application of light, larger lamps or closer spacings are required. The minimum mounting height of 18 ft. should be adopted only where trees are present or other conditions make a higher mounting height impracticable. Mounting heights between 20 and 30 ft. are recommended. For lamps of 10,000 lumens or more, higher mounting heights than 18 ft. become particularly important and should be adopted where practicable.

Heavy Traffic Thoroughfares.—For heavy traffic

thoroughfares the minimum recommended is an opposite arrangement, or equivalent, of lighting units with luminaries located on brackets extending out beyond the curb at a mounting height of not less than 18 ft., even where trees are present; with this mounting height the spacings should not be greater than 150 ft. on each side of the street; with such mounting height and spacing the lamp rating should not be less than 10,000 lumens (1000 candles). This specification is based upon the use of equipment of the most effective type in the most effective manner. With less effective equipment or less effective application of light, larger lamps or closer spacings are required. Where trees do not interfere, mounting heights between 20 and 30 ft. are recommended. With lamps of 10,000 lumens or more, higher mounting heights, than 18 ft. are particularly important and should be adopted where practicable.

Business Districts.—Business streets should be classified as to vehicular traffic in a manner similar to that adopted for thoroughfares and the same minimum standards of illumination should apply for each class, due consideration being given to other local conditions. Retail business streets should never be lighted to a lower standard than that for medium traffic thoroughfares. Where there is considerable pedestrian traffic, these minimum values should be increased.

If the luminaries are not placed over the roadway, lamp sizes should be increased. For a given size of lamp the minimum mounting height should be as follows:

	Not less than
For lamps of 15,000 lumens	20 ft.
For lamps of 25,000 lumens and over	24 ft.
For lamps of 10,000 lumens and less	16 ft.*

Residence Streets-Non-Thoroughfares. — For residence-non-thoroughfare streets the minimum recommended is an 18 ft. mounting height for luminaries located on brackets extending beyond the curb, even where trees are present; with this mounting height the spacing should not be greater than 150 ft., although conditions may sometimes necessitate spacings as great as 200 ft.; with such mounting height and spacing the lamp rating should not be less than 2500 lumens (250 candles). This specification is based upon the use of equipment of the most effective type in the most effective manner. With less effective equipment or less effective application of light, larger lamps or closer spacings are required. At closer spacings a lower mounting height, not less than 15 ft., is permissible. Also 1000-lumen lamps may be used at the minimum mounting height of 15 ft. and closer spacings, preferably not exceeding 125 ft.

Where luminaries are used on center suspension, the mounting height should be not less than 22 ft. and preferably not less than 25 ft.

At intersections of residence streets carrying only local traffic, not less than one 4000-lumen or two 2500-lumen lamps should be installed.

Alleys.—Alleys in business and industrial sections and the entrances, exits and intersections of public alleys in residence districts should be lighted.

Highways.—For the lighting of highways having pavements widths of 22 ft. or less, the minimum recommended is an arrangement of luminaries located at mounting heights of 28 ft. or more and not more than 10 ft. from a point over the middle of the highway; with this mounting height the spacing should not be greater than 325 ft. With such mounting height and spacing, 4000-lumen lamps sould be considered the minimum.

When physical conditions do not permit mounting at such heights, luminaries may be mounted lower (minimum 22 ft.) and with closer spacing. For closer spacing 2500-lumen lamps may serve.

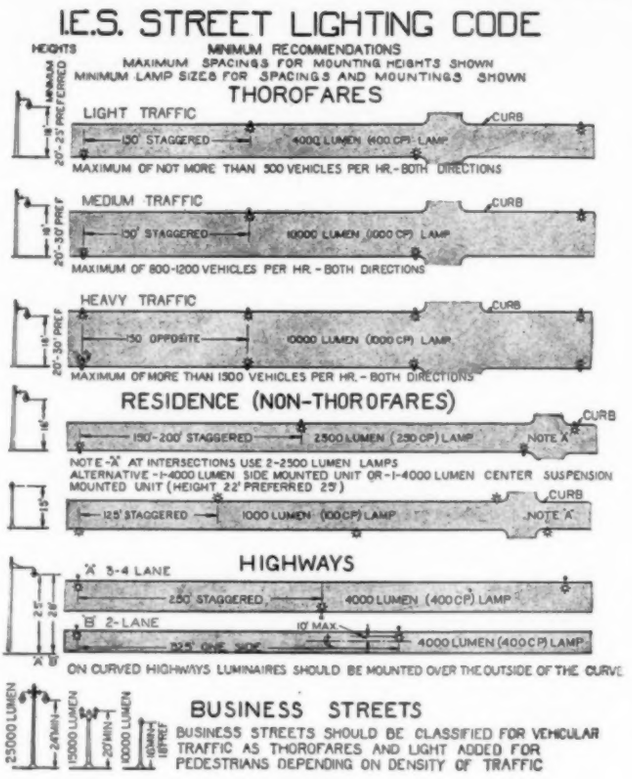
This specification is based upon the use of equipment of the most effective type in the most effective manner. With less effective equipment or less effective application of light, larger lamps or closer spacings are required.

For broad highways carrying heavy traffic, thoroughfare requirement including a staggered arrangement of lighting units, as stated above, should prevail. Luminaries should never be mounted farther from a point over the middle of the highway than the edge of the pavement. In proportion as highways are broad and traffic is heavy, it is important to employ larger lamps, to mount them higher and to space them more closely.

On curved highways luminaries should be mounted over the outside of the curve.

Standards and Architecture.—On ordinary thoroughfares where underground service is available ornamental standards may be used with brackets extending beyond the curb, carrying pendant lamps, with a mounting height of 20-30 ft. Where trees are dense, this may be lowered to the minimum of 18 ft. Where overhead lines exist, heavy ornamental brackets may be mounted on the poles, extending beyond the curb, with pendant lamps of 400 to 1000 C.P.

In business districts of larger cities, the standards should be heavier and more ornamental; the sidewalks are usually wider, providing space for larger bases. They may be constructed to carry trolley span wires and crossing traffic signals, thereby eliminating other structures and improving the street appearance.



*This 16-ft. minimum mounting height is justified only where 1-story buildings predominate.

The standards should be of ornamental design for two or more pendant lamps of from 1000 to 2500 C.P., or even larger, with mounting height of 20-30 ft. and opposite. In the smaller towns single lamps, ornamental standards may be used, carrying 100-1500 C.P. upright lamps, with mounting height of 16-18 ft., depending on the height of the buildings.

On residential streets, the same construction may be used as in ordinary thoroughfares, using not less than 250 C.P. lamps. Where trees are very dense and low, single lamp standards may be used with 15 ft. mounting height and upright lamps not less than 250 C.P.

Where the service is overhead in less important districts, light 4-ft. brackets with 100 C.P. pendant lamps extending beyond the curb may be used with 15-ft. mounting height, spaced not more than 125 ft.

STREET LIGHTING RECOMMENDATIONS SUPPLEMENTARY TO I. E. S. CODE OF STREET LIGHTING RECOMMENDED MINIMUM STREET LIGHTING

Type of Street	Mountings Hgt. in Ft.	Spacing In Feet	Lumens per Lamp	Lumens per Lin. St. F.
Light Traffic	18-25	1 Stag. 150	4000	27
Med. Traffic	18-30	1 Stag. 150	10000	66
Heavy Traffic	18-30	1 Opp. 150	10000	133
Bus. Sts.	16-24	1 Opp. 150	10000	133
Res. Sts.	15-18	1 Stag. 150-200	2500	17-13
Alleys	18	1 Stag. 150-200	2500	17-13
Pk. Drives	18-25	1 Stag. 150-200	2500	17-13
Highways	22-28	1 Stag. 250-325	4000	16-13

RECOMMENDED MEDIUM STREET LIGHTING

Light Traffic	18-25	1 Stag. 150	6000-1000	40-67
Med. Traffic	18-30	1 Stag. 150	10000-15000	67-100
Heavy Traffic	18-30	1 Opp. 150	10000-15000	133-240
Bus. Sts.	16-24	1 Opp. 100	15000-25000	300-500
Res. Sts.	15-18	1 Stag. 125-150	2500-4000	20-32-17-27
Alleys	18	1 Stag. 125-150	2500	20-17
Pk. Drives	18-25	1 Stag. 250	4000-6000	20-48-17-40
Highways	22-28	1 Stag. 250	4000-6000	16-24

RECOMMENDED GOOD STREET LIGHTING

Light Traffic	18-25	1 Stag. 100	10000	100
Med. Traffic	18-30	2 Stag. 100	10000-15000	200-300
Heavy Traffic	18-30	2 Opp. 100-125	10000-15000	400-480
Bus. Sts.	16-24	2 Opp. 80-125	15000-40000	750-2000
Res. Sts.	15-18	1 Stag. 75-125	2500-6000	33-48
Alleys	18	1 Stag. 125	2500	20
Pk. Drives	18-25	1 Stag. 100-125	4000-10000	40-80
Highways	22-28	1 Stag. 250-300	6000-10000	24-33

In the foregoing I have recommended not more than three types of standards and two types of brackets, the fewer types, the better, as it tends to improve the street appearance.

In promoting the aesthetic qualities of the streets, I am suggesting the use of dark brown bronze paint with a yellowish tinge and high gloss. This kind of paint tends to make the lamp standards harmonize with their surroundings and blend with the usual building construction. It is not conspicuous, as it has an antique bronze appearance. It should be sprayed on for the most uniform and best results. It has been used in Albany to the satisfaction of the city engineer. Green paint was supposed to look better among trees, but the dark bronze seems to blend with the tree trunks.

Tree Trimming.—It does not matter how good the street lighting equipment is, or how well it is taken care of, if it is buried among trees so that the light cannot reach the roadway. Public utilities are not in a very good position to trim trees. In order to obtain the best results for street lighting, trees should be trimmed so that the light may reach the street surface. In some communities trees are trimmed 12 ft. above the sidewalk and 18 ft. above the roadway, which has many advantages. It makes proper lighting possible, and is more pleasant for pedestrians in wet weather, also giving trucks better head room, besides a general improvement in street appearance and tree health.

I strongly recommend that the above be given serious thought by public works departments.

Street Light Equipment.—I would suggest to the municipalities not to tie up the utilities too tightly as to the exact kind of equipment they are to furnish, but only as to the candle power of lamps, for in these days the art of lighting is advancing so rapidly that probably long before contracts which are now being made have expired, the present lighting equipment may be out of date. This has happened in the past and, while the utilities were in a position and desired to furnish more modern equipment, they were so tied up by their contracts that they were not allowed to do so.

Street Light Operation.—Street lights have usually been started from stations by an operator on a time schedule complying with the street lighting contract, or by time switches or carrier current systems, all of which have not been entirely satisfactory. The New York Power and Light Corporation is experimenting with photo-electric cells which operate remote control switches, which in turn energize street light regulating transformers. If these come up to expectations, they will turn on and off street lights at the proper degree of daylight intensity rather than a predetermined time. It may be cloudy and light is needed early—it may even at times be so dark during the day that light is needed. This is one of the improvements in service which the utilities are always anxious to render their customers.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 12th annual conference of the International Association of Public Works Officials.

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Mountainous Conditions

Mountain Road Maintenance Is Not Always a Pleasure States LeRoy Dinan, Telluride, Colorado, Who Sends Us This Snow Scene Taken in San Miguel County

EDITORIALS

Et tu Einstein!

THE business depression of 1931 bears the same relation to editors that mothers-in-law used to bear to jokesters. When some enterprising historian shall have gathered into one scrap-book all the editorial articles on "the late depression," there will then be available to students of economics all the wisdom of the ages relating to business cycles. All the causes and all the cures of panics will be marshalled there.

If the same historian will clip and paste into another book all the interviews and articles on the same subject, the same students will learn that nearly every specialist in every type of profession or trade has regarded himself as a specialist also in political economics. Being ourselves one of this economic crew, we had fondly hoped not to have had the illustrious Einstein as an economic competitor. Alas for the hope! He, too, has succumbed to the temptation to tell about his 24-hour researches in a 24-year problem. We find him as the author of a magazine article on the cause and cure of cycles. The contagion of the disease was beyond even his powers of resistance.

Henry Ford was struck by the cycle cause and cure malady when it first started two years ago. All that had to be done to cure the depression, he said, was for big business to maintain wage rates. Perhaps a better cure was to raise wage rates, he thought. So he boosted his lowest paid workers from the previous $6 wage to a $7 wage. Now they are back on the $6 scale—at least those of them that are back on his payroll.

The most popular cure espoused by the newspapers was epitomized in the slogan "Buy now." But somehow it came about that everyone thought that this advice was aimed at some other head than his own. If aimed at his own head, he deftly ducked so that it would hit the head behind him. So the buy-now cure failed to do anything but give a feeling to each newspaper proprietor that he had "done his bit" in the war against depression.

"O time! O customs!" O Ford! O Einstein! O everybody! Aye, and that we do quite merrily—Owe!

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Quantification and Publication Will Reduce Overproduction

ECONOMICS is a quantitative science or it is no science. It professes to deal with income, and income has no meaning until it is expressed in dollars or their equivalent. Political economics is a branch of business economics, but it is in many respects the most complex branch of economics. Its complexity, however, furnishes no excuse for failure to quantify its data and its laws.

All this seems selfevident, yet the vast literature of political economics contains such a relatively small amount of quantified data and so few quantified laws that the plain inference is that political economists in general have failed to realize that theirs is a quantitative science. In short they have failed to pass much beyond the stage of making guesses and arguing about their guesses.

This unfortunate status of the science of political economics has been made particularly evident by the recent report of an international committee on the reparation question. That committee solemnly tells the world that Germany's inability to pay its reparation quota is the basic cause of world wide depression!

America is the greatest creditor nation, and its war allies are committed to the payment of about 250 million dollars annually to America. Americans normally earn 100,000 million dollars annually, or 400 times the 250 millions. It is therefore, absurd to speak of the reparation payments as having the slightest effect upon American prosperity. Yet until quantification and comparison is resorted to, it might be plausibly argued that America is now suffering from the effects of the world war.

If it be urged that reduction in our export business is largely the cause of depression, and that this reduction is consequent upon Germany's inability to meet her obligations, quantification again shows the absurdity of the argument. For several decades American per capita productivity has increased 20 to 25 per cent per decade. In no decade has our total export trade been more than 10 per cent of our production. Hence if we lost our entire export trade, within 5 years our normal increase in production would offset that loss. As a matter of fact, we merely trade our exports for an almost equal value of imports. Hence ceasing to export goods results in our having more goods to consume at home. This, it is true, would cause a temporary glut of certain kinds of goods. Such a glut due to reduced exports has been exceedingly small in America, and utterly inadequate as an explanation of our business depression.

It has been repeatedly said by many writers that the main outlet for our increasing production is through export of a growing surplus. The absurdity of this is shown in two ways: First, by the fact that our exports have always averaged about 10 per cent of our total production, whereas our per capita production is five fold what it was a century ago. Second, by the fact that any relief from general overproduction as a result of exporting goods would be multiplied by the imports which pay for the exports. To the credit of political economists it must be said that they are not responsible for the sophism that overproduction can be avoided by increasing our exports.

Overproduction can be avoided only by stimulating demand and by avoiding rapidly increased production of those goods for which the latent demand is small. Quantitative analyses of the rates at which demand can be increased by advertisements and other sales efforts can be used to guide business men in their programs of business expansion. Then if business associations gather and publish statistics not merely of sales volume and stocks on hand, but of productive capacity and the rate at which it is being increased, it will be possible for intelligent leaders to avoid overproduction in their fields.

Quantification and publication will be two of the most important factors in reducing overproduction and in turning our productive efforts into those fields where latent demand is great.

Ten Billions for Public Works Would End the Depression

THE argument is often heard that to create public work for the purpose of relieving unemployment will prove ineffective because the resulting increase in taxation will correspondingly reduce the wage funds of capitalistic employers. This contention is defective in two respects. It fails to give consideration to the existence of a great volume of idle money. It also fails to allow for the immediate effect of credits upon business activity. Where bonds are issued for public work, taxes are negligibly increased during the period of the expenditure of money thus raised. Hence the wage funds of capitalists are not appreciably reduced.

There should also be considered the fact that few capitalists ever have wage funds of any considerable moment. They commonly borrow extensively to provide working capital for current needs.

Finally, because of the rediscount feature of our Federal Reserve System, our currency is elastic. In times when satisfactory profits are being made and when more profits are in sight, our per capita currency increases because of the issuance of paper money by the Federal Reserve Banks. Money also increases during hard times, because of withdrawals of cash from banks both by necessitous and by frightened depositors, thus causing banks to rediscount notes and secure paper money.

It is debatable to what extent the federal government should issue bonds for public works. President Hoover apparently favors a relatively small issuance of federal bonds and relatively large issues of state, county and city bonds for public works at this time. But is it not likely that large federal appropriations will do more to encourage other appropriations than mere advice will accomplish?

Hearst's advocacy of a five-billion dollar bond issue by the federal government for public works is sound advice.

If the federal government would appropriate $5,000,000,000 and offer to distribute it to states, counties and cities that would agree to match every government dollar with one of their own, for public works, it is probable that the resulting expenditure of $10,000,000,000 would bring the present depression quickly to an end.

Merely to increase public works expenditures by 10, 20 or even 50 per cent can not give sufficient impetus to business to aid much in ending the depression. It can serve only to relieve grievous distress among some of the unemployed. What is needed is an economic effort on a scale somewhat like that that enabled us to end the world war with despatch. We must think and act in billions and not in millions if we are speedily to win the war against unemployments. Otherwise "Let Nature take its course."

W. P. Gillette

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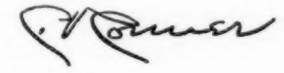
Road Show Displayed Confidence

THE success or failure of any enterprise is significant right now because it indicates to anxious observers the nearness of better times. Particularly is this true of scheduled annual events such as the Automobile Show in New York and the Road Show in Detroit.

Their undisputed success was of national importance and showed the results of courageous and positive leadership in the face of doubt and confusion.

The automobile and highway exhibitors thus displayed more than mechanical equipment—they demonstrated confidence and a will to do.



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Planning County Road Systems

TO clarify any misunderstanding that may exist in the minds of those connected with highway work I desire to explain what the "National County Roads Planning Commission" is and what are its purposes. There is no question of private interest or personal gain connected with the activities of the commission. Every member has participated in giving a great deal of his time and effort as well as actual cash outlay in order to make the work of the commission a success. Maj. Geo. W. Farny, Morris Plains, New Jersey, is chairman.

The history of the National County Roads Planning Commission is of interest. Dr. Johnson, Director of the Lee Highway Association suggested that Prince William County, Virginia, be considered as an exemplary county to study in order to prepare a plan of a comprehensive system of highways in that county. Dr. Johnson submitted his idea to Mr. Charles Henry Davis, President of the National Highways Association. Mr. Davis asked Maj. Farny to study this question with Dr. Johnson and the decision arrived at was that the first question was to determine whether the Prince William County in Virginia was a suitable county for the purpose. In order that this investigation be made, certain funds were necessary. The funds were provided by the National Highways Association.

The work was performed by the Highway Engineering Bureau which reported that they considered Prince William County suitable for the purpose. At that stage it became obvious that an analysis of one county alone, particularly of a county having a distinct agricultural aspect, would not be sufficient for the purpose and therefore it was considered necessary to plan for a more extensive program involving two or even more counties. This program required more funds in order that it could be carried out successfully. It was at the suggestion of Maj. Farny that the National County Roads Planning Commission was organized, the membership of the commission to include national and leading organizations interested in the progress of proper road development in the country.

Both the National Highways Association and the American Road Builders Association, to whom the program of the commission was submitted, have agreed to support the work by voluntary contribution for a period of several years. Additionally when Morris County, New Jersey, was selected as the second county to be studied, the Board of Chosen Freeholders of Morris County promised to assist the work of the commission by a contribution. Since then, the commission has been functioning by regular meetings of its membership directing and controlling the work of paid planning engineers and consultants in Prince William and Morris Counties.

Mr. Charles Davis, Mr. Charles Upham, and Mr. Charles Grubb have assisted at all times between the regular meetings of the commission in settling the numerous problems that have arisen in the work of preparing the plans. Sometime in 1931, Mr. Upham and Mr. Grubb suggested that a manual be prepared as an outcome of the studies made and the first draft of the manual was submitted at the County Officials' Sessions of the Detroit Convention of the American Road Builders' Association.

The Morris County Preliminary Report indicates the magnitude of the problems and the character of the work that the commission has been doing in trying to make a contribution to the art of planning a system of highways in a county.

During this year, final studies of Prince William County and Morris County will be made and the work in the two counties will be completed. It is the aim of the commission to round up the work in a satisfactory manner acceptable to authorities on the subject.

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Political Domination

WHAT can be done to eliminate politics from the highway engineers' work? The characteristic bungling, inefficient methods of political administration dominates too many of our county highway as well as state highway engineering organizations. You know, as do I, cases in both state and county highway administration in which political favoritism and personal political gain are dominating influences. The following was clipped from the *Indianapolis Star* and is published, not because of the personalities involved or their qualifications, but to show an example of political bungling *par excellence;*

"A new controversy over the attempt of the Democratic county commissioners to oust Charles W. Mann as county highway superintendent arose yesterday when commissioners pondered a state law which compels them to pay expenses of the highway department head at the annual road school now in progress at Purdue university.

"The act sets out that the board of commissioners 'shall' appropriate $50 to cover the expenses. Mr. Mann is attending the sessions of the school.

"John S. Mann, the Democratic appointee to the superintendency, is not registered at the school, according to Dow W. Vorhies and Thomas Ellis, members of the Democratic majority faction of the board, who a few days ago voted to discharge Charles Mann.

"The highway law also provides that the county highway superintendent 'shall' attend the road school. With Charles Mann obeying the law and with John Mann awaiting further developments in the ouster proceedings, Vorhies and Ellis will be forced to recognize Charles Mann as superintendent, at least for this week, unless they ignore the act which makes mandatory upon them to pay the expenses of the superintendent at the school.

"The law also provides that a superintendent can be cited for neglect of duty unless he attends the school and from this standpoint removal proceedings could be instituted against John Mann, whom Vorhies and Ellis are trying to recognize as highway head.

"Charles Mann was removed from office following a 'trial' before commissioners. He was found guilty on thirty-four 'counts,' including the charge that he failed to file a 'complete' yearly report. Mann's 1931 report contained more than two hundred typewritten pages and was the most complete report ever filed by a county departmental head. Mann appealed the 'finding' of the commissioners to Circuit court."

Excuses for this condition might be offered in Indiana on the grounds that the Hoosier State, it has been stated, has more petty politics to the square inch than any other state in the union. Marion County is not the only highway building organization in Indiana that is suffering from political rule.

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Road Arithmetic

GIVEN:
1. Millions of miles of farm-to-market roads are mud roads.
2. Mud roads, in the final analysis, are expensive.
3. All-weather road planning considers initial cost of construction as well as cost of maintenance.
4. Light traffic requires proportionately less maintenance than heavy traffic.
5. Light traffic requires less initial cost than heavy traffic.
6. A heavy type of pavement to be properly designed must have a sufficient foundation on a suitable subgrade that permits maintenance of a long-lifed surface at a minimum cost.
7. A heavy type pavement properly designed has a heavy initial cost.
8. A light weight pavement for all weather surface for light traffic has a light initial cost.
9. An economic road surface is one that will carrying the traffic for the lowest total cost.

Problem: What type roads will best serve traffic in counties, rural communities, and sparsely settled states?

Answer: Low cost roads provide a means of serving traffic in these places. They provide a means of prorating the total cost over a period of years. The saving in interest on the difference in first cost of a low cost road and a high type road is sufficient to maintain the roadway at the standard required by the traffic and also return the investment in the first cost over a period of a few years.

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Definitions

On another page in this issue will be found a short article, a request, that fundamental concepts in the field of highway improvement be defined. I have asked that engineers and contractors send me their definitions of construction, maintenance, reconstruction, and widening.

County and Township Roads

County seal for labeling paint

CONTROL OF MATERIALS

For the Construction of County Highways and Bridges

By P. J. FREEMAN

Chief Engineer, Bureau of Tests and Specifications, Department of Public Works, Allegheny County

DURING the past eight years Allegheny County, Pennsylvania, has been engaged in a very extensive road and bridge building program. During that time more than ninety-five bridges have been constructed and several hundred miles of highways constructed or re-surfaced. A few of the bridges were small, costing about seven thousand dollars, but many were large steel or reinforced concrete structures costing from two to seven million dollars. At the beginning of this program it was realized that it would be necessary to have an extensive organization to carry on this work and the Commissioners of Allegheny County engaged Norman F. Brown, an experienced engineer, to create a new Department of Public Works to handle the design and construction of bridges, roads, and buildings.

Organization of Department of Public Works.—The new Department of Public Works was organized with the assistance of those engineers already connected with the county and by the addition of a number of consulting engineers from private practice. Since the entire Department of Public Works was new there were few old prejudices to overcome and very little antiquated equipment. The new Department of Public Works consisted of four principal bureaus, viz., Bridges, Roads, Architecture, and Tests and Specifications, together with appropriate divisions.

Bureau of Tests and Specifications.—Since this article deals with the control of materials, no attempt will be made to discuss the functions of the bureaus in the Department of Public Works other than the work of the Bureau of Tests and Specifications.

It was realized at the outset that in the enforcement of specifications the first consideration is to have the specifications prepared in such a manner that they can be enforced. It is not possible to properly enforce a specification for material or methods of construction which is unfair to the producers of such material or have requirements which cannot be complied with on account of weather conditions or other causes beyond the control of human ability. It was thought necessary to have some co-ordinating agency to see that specifications for materials and methods of construction used by different bureaus and departments were all uniform and equally fair to the county and the contractor.

Experience with state highway departments and commercial testing laboratories had shown the importance of having specifications which would obtain the best

possible material for the purpose without being so rigid that the material could not be obtained from ordinary sources of supply. It was recognized that a Bureau of Tests, as it is usually organized, does not carry sufficient authority to assist in the enforcement of specifications and for that reason the new bureau was created to deal with tests and specifications. This was a new departure in the enforcement of specifications and the only change which the writer feels could be made is to reverse the order and make it a "Bureau of Specifications and Tests," since properly prepared specifications make testing and inspection simply a routine matter.

Duties of Bureau of Tests and Specifications.—In order that there would be no overlapping between the Construction Bureau handling a given project and the Bureau of Tests and Specifications, it was agreed that the latter should engage in activities which are briefly as follows:

(1) Preparation of specifications for materials and method of testing and correlating these specifications with reference to bridge and road construction so that all specifications would be identical.

(2) Make laboratory investigations for materials used for special purposes and prepare suitable specifications for materials such as paint, waterproofing material, special devices or methods proposed for use in bridge and road construction.

(3) Co-operation with the construction engineers in the field in setting batcher plants and obtaining proper temperature control for winter construction.

(4) Complete mill and shop inspection of all castings and metals of every kind.

(5) Plant control of materials, proportions, and mixtures of asphaltic concrete made by the county's own plants, or by contractors' plants, for the construction of bituminous wearing surfaces.

(6) Drilling cores from all completed pavements to determine if proper depth of road slab has been obtained and making the report for the Allegheny County Controller in connection with his approval of the final estimate for payment.

(7) Approval of sub-contracts for materials and of sub-contractors.

Approval of Sub-Contractors.—Of all the above duties the one which undoubtedly saves all parties concerned the greatest amount of annoyance and delays in construction, is the last one mentioned, that of approval of sub-contractors. The specifications of Allegheny County require the contractor to submit in writing immediately after signing the contract information as to whom he proposes subletting any portion of the contract, whether for material or labor, or both. As soon as this information is furnished an engineer in the Bureau of Tests and Specifications immediately communicates with the producers of the material, or with the sub-contractor, and a thorough understanding had as to the requirements of the specifications. If the source of supply is one which has already been used by the County the approval can be given at once. If the producer or sub-contractor is not known it is then necessary to make a very careful inspection of the plant and equipment and thoroughly discuss all of the requirements of the specification. In connection with the construction of a large steel bridge this may require the investigation of between forty and fifty separate material producers; fabricating and machine shops. The writer wishes to emphasize the importance of this procedure. *So far as we know there is no other municipality which investigates and approves every sub-contractor for materials or workmanship of every kind.* Experience with several hundred contracts has led us to believe that this should be the first duty of any engineer in getting a job under way.

Needless to say the approval of such sources of supply must be unbiased and based solely upon an accurate knowledge of the ability of the sub-contractor to furnish the material or do the work in accordance with the specifications. This requires a considerable amount of painstaking investigation of machine-shops and factories of every kind by men who are thoroughly familiar with such plants.

Approval of Sub-Contractors Limits, the Rejections.—The amount of clerical work and labor expended in studying the qualifications of the various sub-contractors for complying with the specifications is fully reflected in the absence of controversies and delays after inspection actually starts. A few letters exchanged well in advance of the time when a material is needed may prevent a serious delay in construction, due to a misunderstanding of specifications on the part of the sub-contractor.

After a mutual understanding has been reached from which the sub-contractor knows what will actually be required and the county is satisfied that such a contractor can comply with the specifications the actual inspection becomes a secondary or routine matter. In dealing with hundreds of reputable producers it has been our experience that most rejections are the result of a misunderstanding of the specifications, rather than deliberate intent on the part of the contractor to cheat.

Anticipation of Construction Needs.—An endeavor is made to assist the contractor in anticipating his needs for various materials and thereby eliminate delays necessary on account of inspection of materials at a time when they are needed in the work. At the beginning of a contract every project is given a Job Number which identifies all samples of materials, as well as correspondence, throughout the progress of that contract. *A large chart is prepared in the bureau office on which are listed all of the materials needed for that particular contract.* These are checked over upon receipt of letters from the contractor requesting approval of sources of supply and an endeavor made to have all materials ordered well in advance of the time when they are needed in order that the necessary correspondence and mutual understanding may be reached with each material sub-contractor.

It is the policy of the Department of Public Works to have inspectors and engineers in the field as well as all other engineers point out special provisions in a specification rather than require the contractor to hunt them up for himself. For example, all steel used as structural members in bridges contains a small percentage of copper, which is known as "Copper Bearing Steel." Special emphasis is placed on the discussion of this requirement whenever the purchase of structural steel is mentioned and no steel is shipped from the mill, or warehouse, until a chemical analysis has been made in the county laboratory to determine if the specifications for copper have been met.

Field Inspection of Concrete Materials.—The general methods for handling the inspection of concrete materials are probably no different from those of other municipalities. The field engineers are furnished with equipment for making as many tests of material in the field as the nature of such material will permit. Undoubtedly the engineer in charge of a job is better qualified to judge as to the suitability of a coarse aggregate for use in the particular construction at hand than a man in the laboratory who sees only a small sample. In cases where controversy arise an engineer from the

Bureau of Tests and Specifications is always available to make as many tests as may be necessary to determine the quality of the aggregate.

It is not the policy of the Bureau of Tests and Specifications, nor of the engineers of the Department of Public Works, to act as detectives in the handling of construction work. It is felt that it is far better to spend the necessary time to properly calibrate a set of scales at a batcher plant and thoroughly instruct the operator as to the exact amounts of fine and coarse aggregates to be weighed or measured and thus guarantee in advance that the correct proportions will be used at the beginning of a job rather than permit the contractor to start work and determine by testing concrete specimens in the laboratory that the strengths are lower than they should be and thereby create a controversy which can be entirely prevented by preliminary work.

This does not mean that field specimens are not taken daily from all concrete jobs, but such tests are for record and to assist in the detection of errors and in the improvement of the product through the information developed.

The resident engineer in the field is furnished for testing coarse aggregates at the batcher plant, as shown in Figure 1. This work is done by a representative of

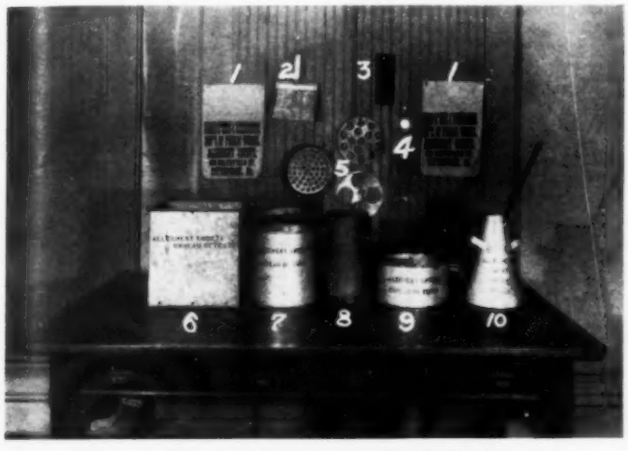

Fig. 1.—Concrete Inspector's Field Equipment

the resident engineer and is further supervised by a travelling inspector. In cases of controversy samples are taken by representatives of the Bureau of Tests and Specifications and delivered to the laboratory for complete tests. The equipment shown is used for coarse aggregates only. The bucket shown under Item 7 is ten inches in depth and used for volumetric measurements of the amount passing the different screens. Since the measure is ten inches deep every inch is equal to ten per cent and experience has shown that this equipment is sufficiently accurate for routine testing since the laboratory is always available for making check-tests by weight.

In addition to concrete cylinders for compression tests beams are made at all important sections of pavement and at intersections. The county owns a number of portable beam-breaking machines, but the field engineers prefer to have the testing bureau do the work and, in general, a beam-breaking machine using dead weight, as shown in Figure 2, is used. This is going back to the first scheme used by Clemmer in Illinois a number of years ago, and in view of the fact that most of our roads are within a short distance of the laboratory the use of the truck is very convenient.

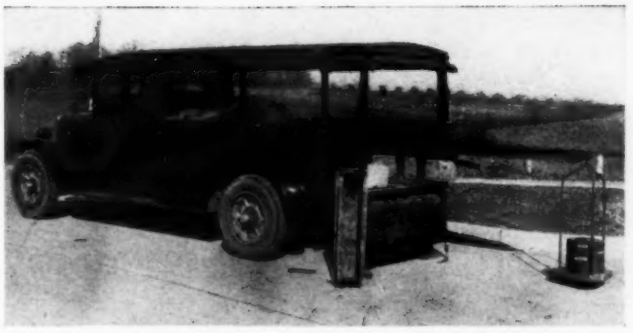

Fig. 2.—Portable Beam Breaking Testing Equipment

Pavement Core Drilling.—At the completion of every pavement contract cores are drilled to determine the depth and in order to make a complete record these cores are crushed in the laboratory. To insure a firm and smooth bearing surface which will correctly indicate the actual strength of the concrete in the pavement the cores are capped in a special device, shown in Figure 3. The material used is a mixture of equal parts of fire-clay and sulphur, heated to a fluid condition. This method was described in the January issue, 1930, of the *National Sand and Gravel Bulletin.*

Inspection of Bituminous Pavements.—Allegheny County has been laying a large mileage of coarse aggregate type bituminous pavements with five county owned asphalt plants and also through contract. All materials and mixtures are passed upon by the Engineer of Tests of this bureau and every plant is furnished with a portable laboratory outfit, shown in Figure 4. The asphalt plants are equipped with recording pyrometers and thermometers for making permanent records and only steam heated tanks for the bitumen are used.

Samples of asphalt cement and of the completed mixtures are rushed to the laboratory for daily tests. All other materials are tested at the plant and the mixtures to be used established by the Engineer of Tests based on the results of the daily tests conducted by the inspector at the plant.

Early each morning the results of the tests made on the previous day's output from each plant are carefully studied. Any variation from the standard is noted by the Engineer of Tests and the necessary changes in procedure are telephoned to the plant concerned. At an early date it was noted that the results in the laboratory

Fig. 3.—Method of Capping Concrete Cylinders in Allegheny County, Pennsylvania, for Testing Purposes

for quantity of bitumen used did not check with the known quantity of bitumen added at the plant. It was found necessary to devise a method of correction which would accurately indicate the amount of asphalt in the mixture. By making a study of the surface areas such a method was devised which has been entirely satisfactory for the size and type of aggregates used by Allegheny County. Such a method is valuable for coarse aggregate type mixtures, but probably not valuable for sheet asphalt.

A complete description of the methods used was published by A. R. Ebberts in Circular 49 of the Asphalt Association, 1927. Mr. Ebberts, at that time, was Engineer of Tests in charge of this work for Allegheny County.

Inspection of Paint.—The paint required in the maintenance of the several hundred bridges is a considerable item and specifications have been drawn covering all of the paint used. The materials are all tested before being incorporated into the paint. These are collected and brought to the laboratory and if satisfactory they are then correctly proportioned and ground in the

Fig. 4.—Asphalt Plant Inspector's Equipment

presence of a county representative. No ready-mixed paints are used for bridge work. The finished paint is weighed into a container and labelled with seals, similar to those shown in Figure 5. When the paint arrives on the job the container must carry these labels or it is not accepted for use.

Wherever possible similar tests are made for all materials at the point of manufacture and the container labelled and held in the warehouse of the producer before shipment is made to the job. This applies to tar and asphaltic waterproofing materials, premolded joint material, crack filler, etc.

Co-operation.—The wholehearted co-operation of all of the engineers, both in the field and in the office, has made the Allegheny County construction program a success. Credit is also due to the various organizations such as the U. S. Bureau of Public Roads and the State Highway Departments, Road Building Associations and others whose hearty co-operation in furnishing specifications, contract plans, and other information made it possible at all times to keep the plans and specifications fully abreast of the latest engineering information.

National Paving Brick Association to Meet in Chicago

The 26th annual meeting of the National Paving Brick Association will be held Feb. 10, 11 and 12 at the Palmer House, Chicago, Ill. The preliminary program follows:

WEDNESDAY, FEB. 10
Morning

10:00 A. M.—Registration.
10:30 A. M.—Annual Meeting, Board of Governors of the National Paving Brick Association.
12:00 M.—Luncheon.

Afternoon

2:00 P. M.—Business Session (for the industry).

THURSDAY, FEB. 11
Morning (9:30 A. M.)

1. Recent Developments in Brick Paving.
(a) General Design and Construction, by H. G. Sours, County Engineer, Akron, Ohio (Chairman of the Committee on this subject of the American Road Builders' Association).
(b) Fillers and Bedding Courses, by Prof. John S. Crandell, University of Illinois (Chairman of the Committee on this subject of the Highway Research Board).
(c) For Municipalities, by R. L. Phillips, City Engineer, Meadville, Pa.
Discussion by
(a) B. P. McWhorter, State Highway Engineer of Georgia.
(b) Thos. M. Reed, Chief Engineer, Bureau of Engineering, Pittsburgh, Pa.
(c) Rodney Bell, Contractor, Paris, Ill.
2. Paving Brick for Sewers and Tunnels.
(a) By George H. Sanderburgh, City Engineer, Ann Arbor, Mich.
(b) By A. J. Hawkins, City Engineer, Birmingham, Ala.

Afternoon (1:30 P. M.)

1. Replacement with Paving Brick.
(a) In Newburgh, N. Y., by William J. Blake, City Engineer, Newburgh, N. Y.
(b) The Washington Street Bridge, by A. B. Shaw, County Engineer, Wilmington, Del.
2. Relaying and Salvaging Paving Brick.
(a) In Albany, Ga., by C. Q. Wright, City Engineer.
(b) In Chillicothe, O., by George F. Driscoll, City Engineer.
3. Brick Airport Runway Transition Strips, by P. W. Maetzel, Asst. City Engineer, Columbus, O.

Night (7:30 P. M.)

Annual banquet.

FRIDAY, FEB. 12
Morning (9:30 A. M.)

1. Financing Municipal Paving, by Pere S. Seward, Engineer Executive, American Road Builders' Association, City Officials' Division.
Discussion by William N. Carey, Chief Engineer, Department of Public Works, St. Paul, Minn.
2. Paving Brick for Resurfacing, by C. M. Hathaway, Construction Engineer, Illinois Division of Highways.
Discussion by E. J. Fraser, McCarthy Improvement Co., Davenport, Ia., and G. C. Snyder, Chief Engineer of Maintenance, Ohio Department of Highways.

Afternoon

Inspection trip.

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HARD-SURFACED ROADS IN U. S.—There were 693,559 miles of surfaced rural roads in the United States at the beginning of 1931, according to statistics collected by the Bureau of Public Roads of the United States Department of Agriculture. This mileage is made up of 226,221 miles of state highways and 467,338 miles of county and other local roads. The total rural road mileage is reported as 3,009,066.

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The Lakewood Engineering Company have just published a bulletin on the use of their finishing machine on bituminous roads. It describes methods of employing the machine on a few types of black top roads. Finishing bituminous roads by machine is a forward step and should be encouraged. After all, what the public notices about a road is the smoothness of its riding surface.

ARE YOU A JACKASS ?

What Are You Going To Do About It

Answer: Put Your House In Order. Provide Sound County Road Laws and a Just and Equitable Apportioning of Funds for Highway Improvement

By W. M. CONNELLY
President, Michigan State Good Roads Association

MY subject is not camels, nor governors, nor elephants. It's "Jackasses." That's what we county road commissioners and engineers are if we permit conditions to go on as they are now going.

We need a purging and housecleaning. We should take stock and determine what is needed to put our house in order and then do it even if it stings to the quick. If we don't do it every state in the union will follow the lead of North Carolina, whether it be for better or for worse. I predict it will be for worse. I think centralization of administration can be and has been carried too far in many instances and there will be a reaction just as in the manufacturing industry. Our own good governor is now advocating a decentralization of industry.

What Happened in North Carolina.—For the benefit of any of you who do not know what has happened in North Carolina, I shall briefly outline it. Under the leadership of the governor and the slogan "Taxes on property must be reduced" the 1931 legislature passed four acts. In the words of the governor, "Legislation largely without precedent in this Nation. Each was revolutionary, but each was designed to meet the situation prevailing under changed economic conditions."

These measures were as follows:

1. On a given date the state to take over all public roads.
2. Placed power of limiting local debt in hands of a State Commission.
3. Consolidation of the three major state educational institutions.
4. Increase franchise and income tax 40 per cent to enable state to finance public schools.

The first measure of course is the one that most interests us and which we must be confined to because of the short time allotted us.

Now, I shall continue to quote the Governor. I am trying to be more accurate than the woman who was asked just where the cow was being milked, she replied, that she thought, just a little back of the middle.

"On a given day the *maintenance* of every mile of public road in North Carolina should be transferred from the counties and townships to the state, that their support should be lifted from the county property tax, and that county boards *should be prohibited from levying any tax for road maintenance.*

"The position of the administration was that roads should be supported by those who use them and that the overwhelming majority of country people were not getting a fair return from the proceeds of the gasoline tax. All owners of gasoline vehicles paid this tax, but the tax was used almost exclusively for the support of the state highway system—the 9,000 miles of trunk lines connecting the principal towns. The 60 per cent of the country people living off the state highways paid their gasoline tax and then for most of their travel used only their neighborhood roads—maintained by property tax. The proceeds of the gasoline tax scarcely reached the church, the rural-school and farm-to-market roads.

"The magnitude of this proposal when first made jarred the complacency of the public mind. This shock can be appreciated when I state that it involved the abolition of more than 175 county and township road boards and the elimination of some 600 local road officials. My own county of Cleveland had 11 townships road boards and 33 road commissioners whose positions were abolished. The transfer involved the state's assumption of an expenditure that was costing $8,250,000 a year.

"The survey made by the United States Bureau of Public Roads gave us our first authoritative picture of the scope of the local road problem. The Federal Bureau stated that it presented the most complete information on local roads ever assembled in any state. During the past ten years the counties had invested $125,000,000 in roads, and $100,000,000 of this stood on the books in the form of bonded debt. The survey reported that the indebtedness still outstanding represented a sum *far in excess of the present worth of the roads remaining in the county systems.* Many counties had heavily bonded themselves to construct roads and then had failed to maintain them. Every mile of road in every county was mapped. Each road was classified according to its surface and its service. *Before the survey was made, we did not know how many miles of county roads we had.* Our reported information was estimated and largely inaccurate. Instead of the counties having a total of more than *66,000 miles,* which

they showed in their official reports to the state and to the Bureau of Public Roads, and on the basis of which they made their tax levies and also shared in a $4,000,000 state-aid fund, the survey found that they actually had a total of only *45,090 miles.*

The 1-Arm Man Maintenance Outfit.—"The survey revealed further that our road system was good in one county and bad in another; that there was no standardization nor uniformity among the counties either as to the cost, quality of service, or efficiency of performance. When the transfer was made from the counties, it was found that the entire road force and equipment in one county consisted of a one-arm man, a homemade drag and a blind mule. Another county transferred enough machinery to maintain all its own roads and the roads of the four adjoining counties.

"The bill as passed provided for: First, the transfer of the maintenance and support of all county roads to the state, the abolition of all county and township road

Among those present at the County Officials Dinner were Maj. G. W. Farny, J. W. Hannan, C. E. Grubb, Gov. Brucker, J. H. McDonald, Otto Hess, and W. M. Connelly fourth from left.

boards, and no tax levy by the counties for road maintenance or construction. Second, the maintenance of county roads from the gasoline tax, which was increased from 5 ct. a gallon to 6 ct., and an appropriation of $6,000,000 a year made for county roads. Third, the designation of the boards of county commissioners as liaison units between local communities and the State Highway Commission, and the appointment of a state director of local roads to deal with local communities.

"The law as passed was a clear cut victory for centralization of control and the fixing of administrative responsibility, as against diffusion of authority and a necessary inefficiency of administration. It cut the annual cost of road maintenance $2,250,000 and though it increased the gasoline tax $2,500,000 it abolished the property tax levy for roads, which last year was $5,500,000."

County Conditions in North Carolina.—Now let us see what the conditions were in the counties of North Carolina that warranted such a drastic step which may or may not be a wise one. I will say this much; this new law paves the way for a politically minded highway commissioner or governor to build a most perfect political machine imaginable.

Can you conceive of a county road board not knowing how many miles of roads in its county system? That is inexcusable. Can you conceive of such inequalities and lack of uniformity in management and condition of roads among the counties. I can, if their county road laws were bad and no proper proportioning of weight and gas tax back to the counties. I can believe for the same reason that one county may have enough machinery to maintain its roads and those of four other counties if the commissioners in office were of the wrong type. It is also possible for the entire force of one remote county without funds to consist of a one armed man, a home made drag and a blind mule if the funds available only admitted of such a force.

We have enough inefficiency, misfeasance and malfeasance right here in some of the counties in Michigan to incite a movement similar to that adopted in North Carolina and I suppose many of you would make the same confession if called upon. Perhaps I do not appear very optimistic, well I am not. *An optimist is one who would eat wormy nuts in the dark, a pessimist is one who has.*

The Movement in Other States.—Now I have given you an outline of what has happened in one southern state. Pennsylvania is a close second. Twenty thousand miles of local roads were added to the state system of 13,600 which was almost a complete take over.

Arkansas gave the matter serious consideration at the last session of Legislature.

California added 800 miles this year to the state system.

In Connecticut which has had no local unit of highway administration is hardly to be considered as it is not much larger than some of our western counties. Massachusetts is headed in the same direction.

North Dakota has recently increased the percentage of state road mileage but limited it to a definite total.

Utah added 670 miles to the state system this year.

County Unit Most Practical.—I think we can all agree that the township unit is too small for efficient administration. But I am positive that state control of local roads is too remote, that the people's interests will not be best conserved by state administration and that the county unit is most practical. Provided, of course, we have sound county road laws and a just and equitable apportioning of motor vehicle funds.

No doubt this change has been precipitated by the outcry against high taxes and no money to pay them. For relief the roads are turned over to the state. Our position should be that the state turn the money over to the counties. Let us admit for argument's sake that a slight lowering of overhead might be gained by state control. The difference won't be enough to build a mile of road. So the state must get the money from some source. Why not have the same source produce it for the counties.

"This hoss trade ain't going to build more roads." If such a change takes place in Michigan I can see each county spending more than the wages of the commissioner every year for transportation of delegations to the capital every week to lobby for road improvement in their respective baliwicks. Oh what possibilities for paying political debts—Brothers there's dynamite in this thing, we've got to get busy and destroy the fuse.

What Are We Going to Do About It?—Perhaps I should say what can we do about it. We can consolidate and strengthen our county road commissions and engineers associations. In states where no organizations exist they should be organized. We should have strong and fearless legislative committees who shall demand the enactment of legislation that will safeguard the public against unfit and unscrupulous officials. We should ask for restrictive legislation to save us from

our own weaknesses such as contracting over-burdensome debts during times of inflation. If the law says the duties of commissioners shall be executive and competent engineers and managers should be employed to administer the affairs of the county, then we should respect the law.

I cannot refrain from a parting shot at the Carolina set up. The gas tax has been hiked from 5 ct. to 6 ct. per gallon. Yet the governor said he was opposed to a sales tax. In the name of heaven by what other term can he call the gas tax. Down in Florida they raised the gas tax to 7 ct. and they are now collecting less money than they were at the 6 ct. rate which shows where the breaking point is on taxing this important commodity.

Now we know what can happen to a state that has loose county road laws and looser commissions. We should take this thing to heart and return to our respective states and endeavor to put our house in order.

Acknowledgment.—The foregoing is an address given at the County Officials' dinner at the recent convention of the American Road Builders Association.

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New Jersey Surveying Methods and Equipment

By S. JOHANNESSON

Engineer of Design, New Jersey State Highway Commission, Trenton, N. J.

DURING the last few years the Jersey City Ofment has been engaged on work involving exfice of the New Jersey State Highway Departtensive surveys requiring a high degree of accuracy. For about a year attempts were made to obtain the desired results with ordinary equipment; but these attempts were not satisfactory as they involved too heavy expenditures, both in time and money. New methods were developed, therefore, based in principle on similar methods used by the U. S. Coast and Geodetic Survey, and these proved entirely successful.

For measurements of angles, a Berger transit-theodolite was used, having a 7-in. circle, reading to 10 seconds. Angles were measured by the repeating method, at least three complete sets of six repetition each being made at each station, and the average of these readings being used to determine the angle. The average closing error has been about one-half second per station occupied. The stations were marked by a cross on a copper nail set in a hub or in a plug driven into a hole drilled into the roadway pavement. The reading of the angles at three or four stations usually constituted a day's work.

For measurements of distances were used ordinary steel tapes. One such tape had been standardized by its maker and was used only for the purpose of comparison. The first tapes used had the usual black finish, but considerable trouble was caused at times by the effect of the sun on these tapes. They were replaced, therefore, with similar tapes having a nickel plated finish, in the hope that these would maintain a more constant temperature, and the results obtained seem to justify their use.

For measurement points of 2 in. x 4 in. stakes or crosses cut in the sidewalks or roadway pavements have been used. The stakes were left about 2 ft. high, so that the sag of the tape would clear the ground, and were held in place by means of 1 in. x 4 in. inclined braces. Copper nails marked with a cross were used for centers. The distance between measurement points has always been less than 100 ft.

Much of the more recent work has been on paved streets or over railroad tracks, and has required the use of plumb bobs at the ends of the tape. This use of plumb bobs has been found slow and gave unsatisfactory results. In order to improve this matter, a tripod was devised and constructed, consisting of one bent steel rod and another rod reaching beyond the bent rod at the top. This tripod is about 18 in. high, weighs about 25 lb., and has a measurement point at the top. This measurement point is set over the point on the pavement by means of a plumb bob, but no attempt is made to place it exactly over the pavement point, except at the angle points at the ends of the line measured.

Four of these tripods are used in a survey, two being carried ahead and set while measurements are being taken on the other two.

Additional equipment consists of a spring balance, fastened to the 100 ft. end of the tape, and a pocket thermometer with part of the casing cut away to show the graduations. This thermometer is fastened directly to the tape at the 100 ft. end.

In operation, two men hold the zero end of the tape exactly on the mark, while the man at the other end pulls the balance up to the tension required for the tape in use. This pull is usually about 18 lb. A fourth man touches the tape in the center to prevent vibration, but is careful not to support it, and the chief of party reads the tape over the stake or tripod. Tension is then relaxed for a few seconds, then the tape is pulled up again and the measurement repeated. If it checks the first reading, the party moves ahead, supporting the tape. If the two measurements do not check, they are repeated until two or more identical readings are obtained. The whole line to be measured is gone over in this manner, and then a second measurement is made over the whole line.

Distances and temperatures read are recorded in the field book, and the recorded distances are reduced to standard temperature in the office. Horizontal distances are computed from the differences in elevation and the slope distances. Check measurements are made when the computed distances from the two sets of readings differ by more than 1/50,000. It has been found possible to measure more than two miles per day by this method.

Acknowledgment.—The foregoing is a portion of the report of the Committee on Highway Location, presented at the 1932 Convention of the American Road Builders Association.

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ILLINOIS PUBLIC WORKS LAW INVALID.—The Supreme Court of Illinois held, by a unanimous decision on Oct. 20, that the so-called prevailing wage law of Illinois is unconstitutional. The law (S. 307) was enacted by the 1931 General Assembly. The law required that in all contracts for public work, including road building, there shall be a clause requiring the payment by the contractor of not less than the rate of wages prevailing in the community where the work is being done and that the work day shall not exceed eight hours.

BEFORE

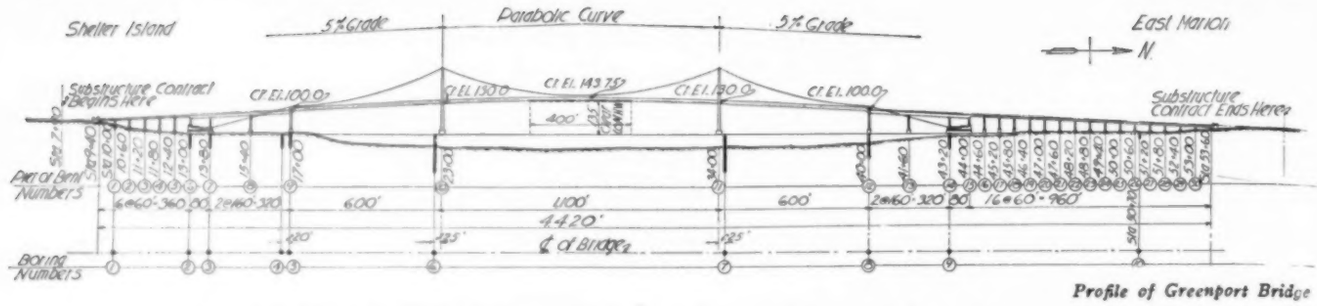
A garbage dump on Yonkers Avenue, Westchester County, New York, was not exactly a pleasing view or restful scene for pleasure seeking New Yorkers on their Sunday afternoon drives.

Who would have thought, driving this road a few years ago, that this

AFTER

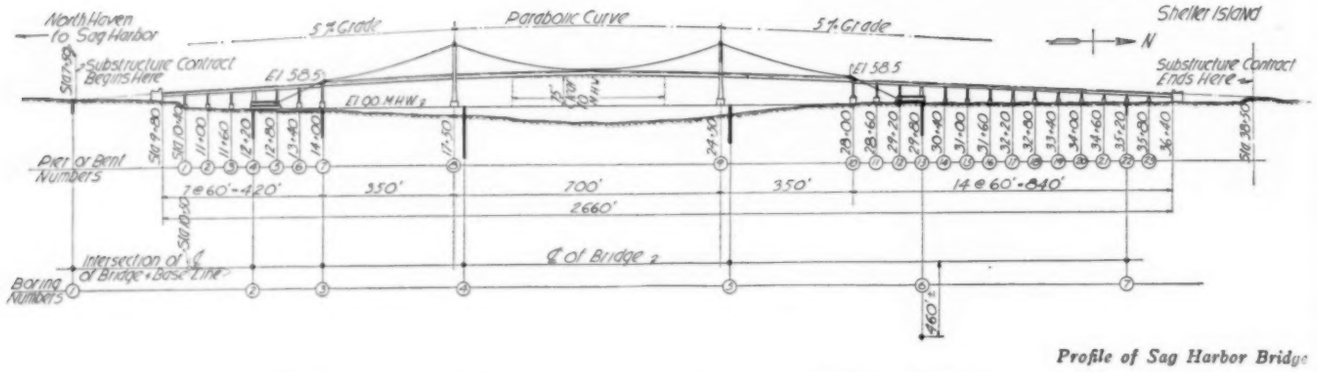
So the Westchester County Park Commissioners took effective steps toward eliminating the nuisance with the result that what was once a disgusting spot is now a terraced parkway.

magnificent change would be wrought before the old car was discarded?



Profile of Greenport Bridge

COUNTY is Building



Profile of Sag Harbor Bridge

Two Suspension Bridges

By WM. G. GROVE
Robinson & Steinman, Consulting Engineers, New York City

Suffolk County, New York, Adopts Suspension Type After Economic Study of Various Designs for Shelter Island Bridges

DURING the years 1932 and 1933 there will be constructed two large suspension bridges out at the eastern end of Long Island connecting Shelter Island to the northern and southern forks of Long Island. See Fig. 3.

These bridges will be constructed by the County of Suffolk, New York, with a portion of the funds from a $5,000,000 bond issue voted by the County Board of Supervisors the early part of this year. The two structures will, when completed, form parts of the Suffolk County road system. At the present time there are two main arterial highways extending eastward on Long Island along the Sound and along Great South Bay respectively, but the only connections at the eastern ends of these highways are by means of ferries.

Shelter Island is a small, irregular piece of land about 4 miles in length and the same in breadth. It lies between Peconic Bay on the West and Gardiners Bay on the East, and is separated from the northern and southern forks of the mainland by Shelter Island Sound. The northerly strait is about 3000 feet wide, the southerly strait being only 2000 feet in width.

The waters in the vicinity of the eastern end of Long Island constitute the pleasure ground of the Atlantic Seaboard yachtsman, so that provision had to be made for either a high-level type of fixed bridge or for a low-level type bridge with a movable span.

Various preliminary studies were prepared by Robinson & Steinman, involving low-level structures with swing spans and bascules, and with high-level structures of the cantilever, arch, and suspension types. On account of the deep water and wide channel conditions, it was soon found that there was not much difference in cost between the high-level fixed bridge and the low-level bridge with a movable span, especially when the maintenance and operation features of the latter type were taken into consideration.

The suspension spans proved to be more economical than the other high-level types and also harmonized very satisfactorily with the beautiful scenery at the two sites. The graceful curves of the main cables and the lofty steel towers with their Gothic arches blend in with this picturesque location.

Principal Dimensions.—The Greenport or northerly bridge will have a main span of 1100 feet center to center of towers, flanked on either end with side spans of 600 feet each, making a distance of 2100 feet between cable bents. Each approach viaduct consists of a series of truss and girder spans on steel columns.

The Sag Harbor or southerly bridge will have a main span of 700 feet center to center of main towers, flanked on either end with side spans of 350 feet each. Each approach viaduct to this bridge will consist of a series of deck plate girder spans on steel columns.

The Sag Harbor bridge will have an underclearance of 75 feet (for a clear width of 400 feet), this being ample to provide for the pleasure and commercial boats that would use the southerly channel. The Greenport bridge, however, will be provided with an underclearance of 135 feet (for a clear width of 400 feet). This large vertical clearance, the same as that used for spans over the East River and other navigable rivers along the Atlantic Seaboard, will permit the passage of all commercial vessels and of all pleasure craft except the six cup defenders and very few yachts which have no provision for housing their topmasts.

Foundations.—Borings were made at both sites at the locations to be occupied by the piers. All borings showed the soil to consist of sand, gravel and clay. No rock was encountered, although some of the borings were carried as deep as 149 feet below the surface of the water. This simplified the design somewhat, as all foundations rested on the same character of material.

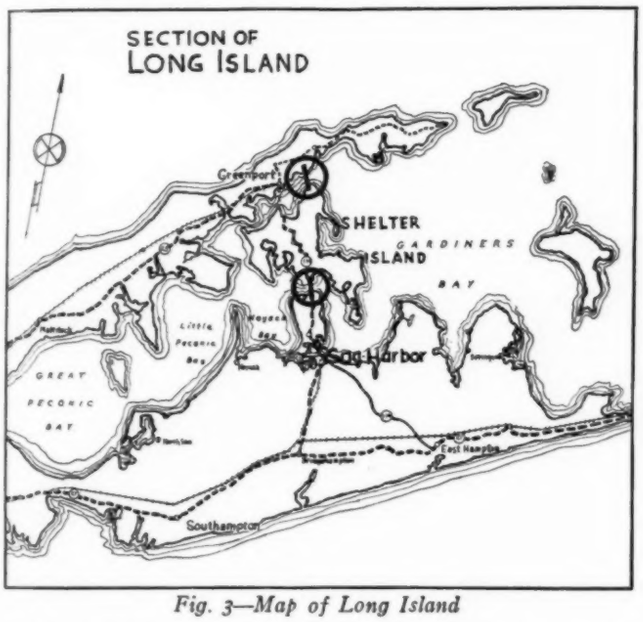


Fig. 3—Map of Long Island

All piers are of reinforced concrete and all foundations rest directly on the soil. No piles, either wood or concrete, are used in the design. Each main pier for the Greenport bridge has its foundation at El. —75 and contains about 6600 cu. yd. of concrete and granite. Each main pier for the Sag Harbor bridge has its foundation at El. —47 and contains about 2500 cu. yd. of concrete and granite. In order to prevent scour under the main pier foundations, the lower portions of the steel sheet piling will be left in place and in addition rip-rap will be placed around each main pier. See Fig. 4.

Each anchorage of the Greenport bridge is 108 feet long and 49 feet wide. The south anchorage extends from El. +31 to —33 and contains about 8000 cu. yd. of concrete and granite, while the north anchorage extends from El. +31 to —44 and contains about 16,000 cu. yd. of concrete and granite. The south anchorage contains about 1000 cu. yd. of sand fill and 92,000 lb. of reinforcing steel, while the north anchorage contains about 1200 cu. yd. of sand fill and 95,000 lb. of reinforcing steel. Steel sheet piling will be left in place at both anchorages and rip-rap will be placed around the north anchorage.

Each anchorage of the Sag Harbor bridge is 85 feet long and 45 feet wide. The north anchorage extends from El. +22 and —27 and contains about 4900 cu. yd. of concrete and granite, while the south anchorage extends from El. +22 to —35 and contains about 5500 cu. yd. of concrete and granite. The north anchorage contains about 400 cu. yd. of sand fill and 68,000 lb. of reinforcing steel, while the south anchorage contains about 300 cu. yd. of sand fill and 72,000 lb. of reinforcing steel. Steel sheet piling will be left in place at both anchorages and rip-rap will be placed around the south anchorage.

The main piers, cable bent piers, anchorages and some of the viaduct piers are faced with granite. The anchorage steel consists of eyebars extending from the strand assembly to the grillage girders which are embedded in the masonry anchorages.

Main Towers and Cable Bents.—The main towers are of the flexible type fixed at the base. The Gothic motif was adopted in the towers for both bridges, as the suspension bridge tower lends itself admirably to the lofty Gothic arch type.

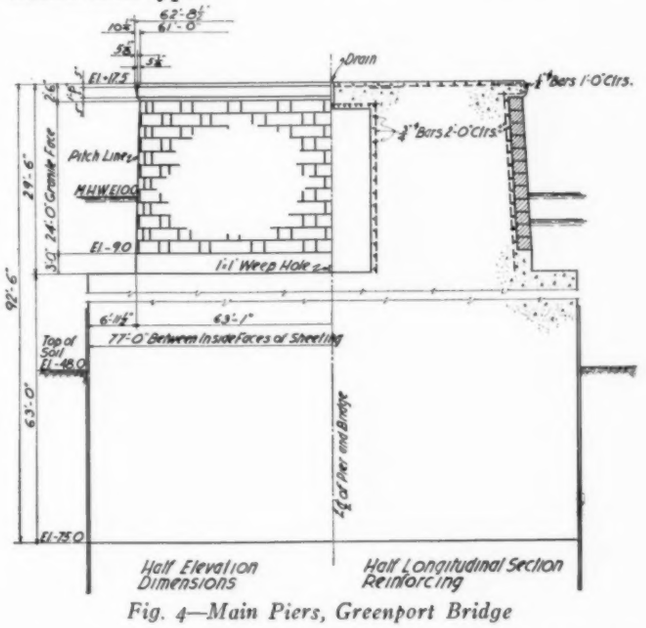


Fig. 4—Main Piers, Greenport Bridge

The Greenport bridge towers are 250 feet high and consist of two main vertical columns supplemented with outside batter legs. Where height is necessary the combination of vertical and batter legs adds to the aesthetics of the tower and emphasizes the appearance of added lateral rigidity. The towers of the Sag Harbor bridge are only 150 feet in height and independent batter legs are unnecessary. The main vertical legs are, however, flared near the base to provide the necessary lateral rigidity. The main column section of the Greenport bridge tower tapers from 15 feet at the base to 7 feet under the cable saddles with a constant width of four feet. The column section of the Sag Harbor bridge tower tapers from 11 feet at the base to 5 ft. 9 in. under the cable saddles with a constant width of 2 ft. 6 in. See Fig. 5.

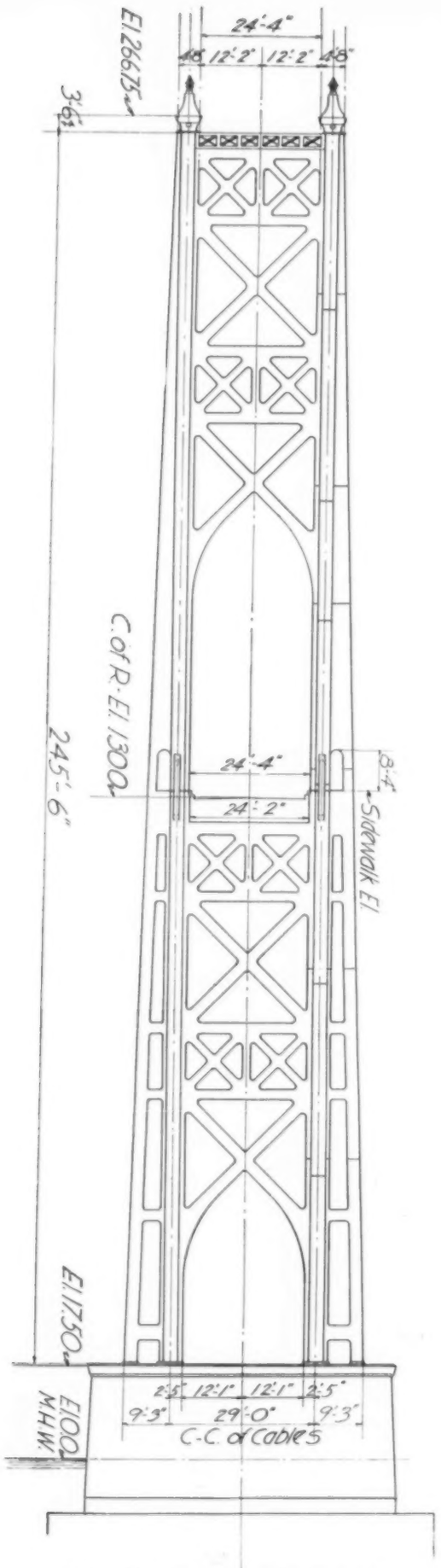


Fig. 5—Main Tower, Greenport Bridge

The cable bents are of the rocker type and the cross girders of the cable bents support the adjacent truss spans in the Greenport bridge and adjacent girder spans on the Sag Harbor bridge. These trusses and girders are supported on rockers on the cable bents.

Twisted Strand Cables.—The successful use and low cost of the twisted wire strands in the Grand'Mere, Portland and Bucksport bridge cables led to their adoption for the Shelter Island bridges. While the specifications permitted bidding on an alternate cable made up of parallel wires, not one of the four bidders took advantage of this possible substitution, showing conclusively that for spans of 700 feet and 1100 feet, cables made of strands are more economical than cables made of parallel wires.

Each main cable consists of 61 strands $1\frac{7}{16}$ in. in diameter, for the Greenport bridge and 37 strands $1\frac{7}{16}$ in. diameter for the Sag Harbor bridge. The use of 61 and 37 strands meant that these strands would normally form hexagonal cables, as no squeezing is done to cables made of strands. To convert these cables into circular form in order to permit of placing the wrapping wire, six wood block fillers are placed, one filler on each side of the hexagon. The resulting cable diameters are 13 in. for the Greenport bridge and 10 in. for the Sag Harbor bridge.

The metallic area of each strand is 1.22 sq. in. The physical properties per strand are, minimum ultimate strength 234,000 lb., minimum yield point 173,000 lb., modulus of elasticity not less than 24,000,000 up to 50 per cent of the ultimate strength.

The individual wires comprising the strands are required to conform to the following physical properties:

Minimum Tensile Strength, 220,000 lb. per sq. in.

Minimum Average Yield Point, 170,000 lb. per sq. in.

Minimum Elongation in 10 inches, while under tension, 5 per cent.

Minimum Reduction in Area, while under tension, 30 per cent.

Strand Assembly.—The strand assembly in general follows the details used on the Grand'Mere, Portland and Bucksport bridges. There are nine tiers of strands for the Greensport Bridge made up as follows:

5 strands in tiers 1 and 9
6 strands in tiers 2 and 8
7 strands in tiers 3 and 7
8 strands in tiers 4 and 6
9 strands in tiers 5

making 61 strands in all.

All strand plates are 1 inch thick and are reinforced with pin plates where they connect to the anchorage eyebars by means of a 10½-in. pin.

The strand assembly for the Sag Harbor bridge consists of 7 tiers of strands, made up as follows:

4 strands in tiers 1 and 7
5 strands in tiers 2 and 6
6 strands in tiers 3 and 5
7 strands in tiers 4

making 37 strands in all.

All strand plates are 1 inch thick and are reinforced with pin plates where they connect to the anchorage eyebars by means of a 9-in. pin.

The strand sockets bear against cast steel bearing blocks which in turn are held in place between the strand plates by long bolts.

Stiffening Trusses and Viaduct Spans.—Both bridges were designed for two-lane vehicular traffic on a 22-ft. roadway. See Fig. 6. A double curb in two steps of 9 inches each and a narrow footwalk on each side result in the stiffening trusses and cables being 29 feet

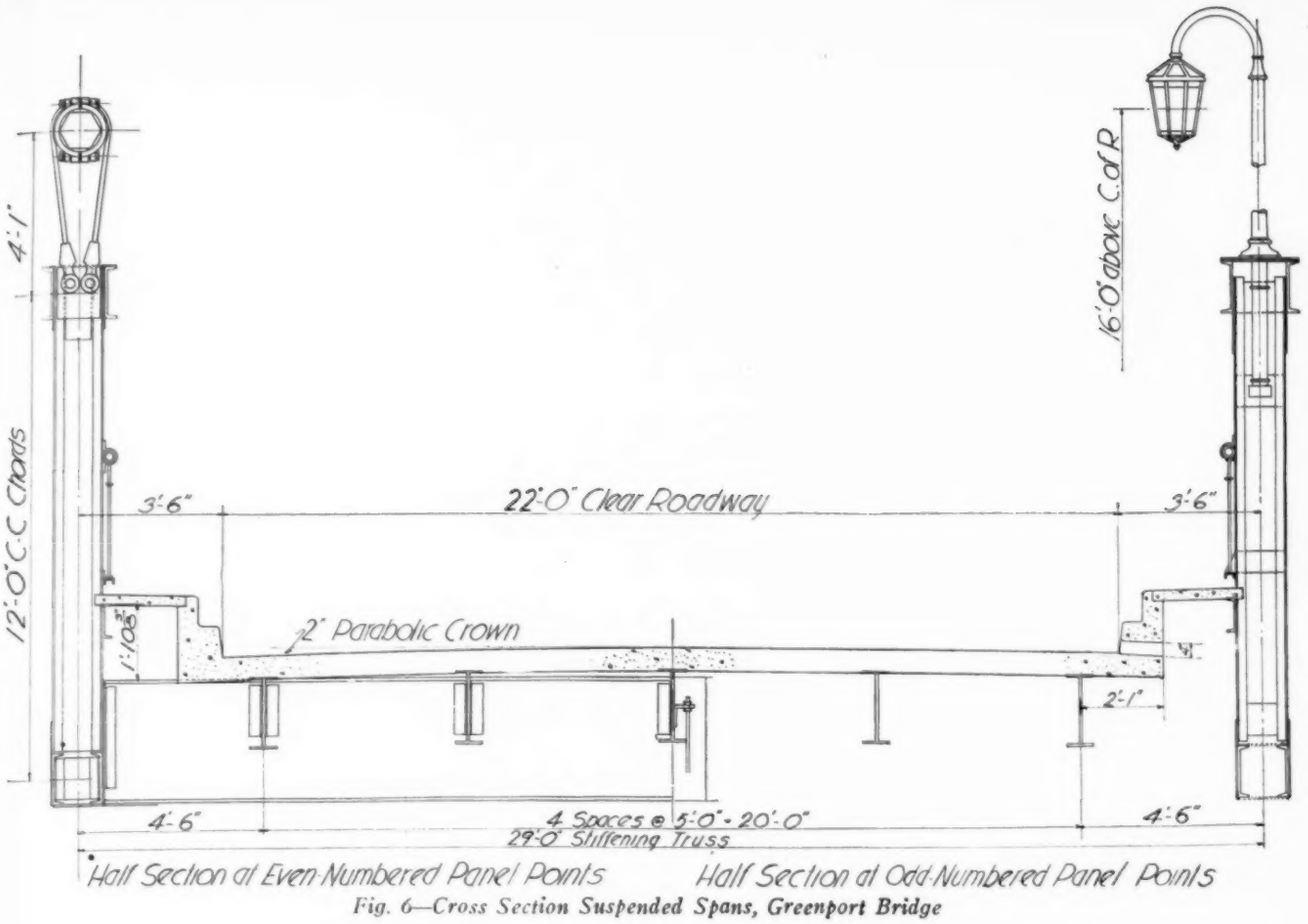


Fig. 6—Cross Section Suspended Spans, Greenport Bridge

center to center. On the Greenport bridge the trusses are 12 feet deep center to center chords or one ninety-first of the span length of 1100 feet; while on the Sag Harbor bridge the trusses are 8 ft. 9 in. deep or one-eightieth of the span length of 700 feet. The panel lengths are about 12 feet and 10 feet in the Greenport and Sag Harbor bridges respectively.

In the Greenport bridge the main chord material, splice plates and gusset plates for the chords are silicon steel, the balance of the span material being carbon steel, while all span material for the Sag Harbor bridge is carbon steel. Truss field splices for the Sag Harbor

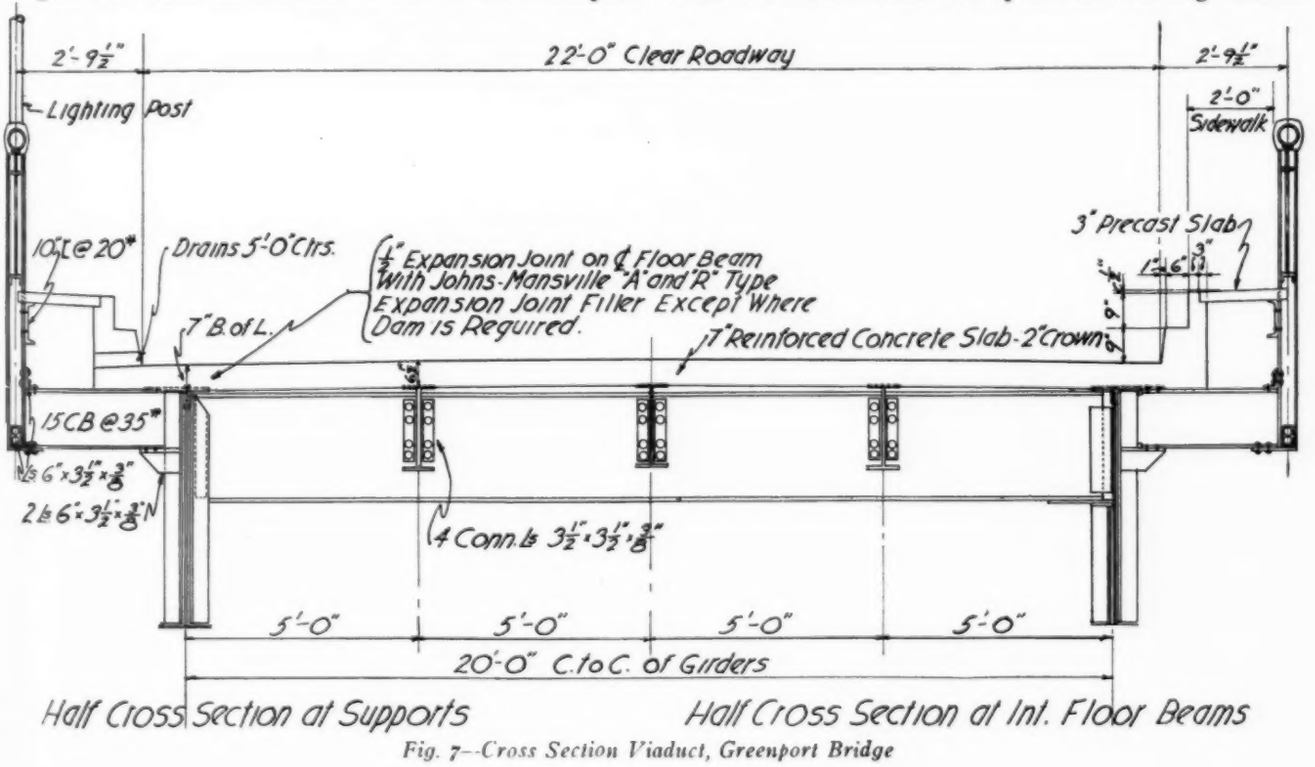


Fig. 7—Cross Section Viaduct, Greenport Bridge

bridge are located so as to provide for the fabrication, shipment and erection in two-panel truss units approximately 20 feet long. Truss expansion is provided at the towers for both main and side spans so that all horizontal movements are taken care of, but vertical motion is prevented.

On the Greenport bridge three truss spans, two of 160 feet and one of 80 feet, flank the side suspension spans and form the transition from the main bridge to the plate girder viaduct. The viaduct spans are all 60 feet long, there being 6 on one end and 16 on the other end. All approach spans rest on steel columns except where they are supported on the cable bents, anchorage and abutments.

On the Sag Harbor bridge there are no truss spans but the entire viaducts are made up of 60-ft. girder spans, there being 7 on one end and 14 on the other end. All viaduct spans are supported on steel columns except where they rest on the cable bents, anchorages and abutments.

A special feature of the viaducts for both bridges is the fact that the girders and trusses are designed as continuous beams over several supports. Both truss spans and girder spans are of the deck type, 20 feet center to center, the sidewalks being cantilevered out on brackets. See Fig. 7.

Quantities.—The principal quantities of material to be used in these two bridges are as follows:

	Greenport Bridge	Sag Harbor Bridge
Earth excavation	22,000 cu. yd.	12,000 cu. yd.
Concrete	39,000 cu. yd.	20,000 cu. yd.
Granite	1,300 cu. yd.	1,000 cu. yd.
Rip-rap	4,700 tons	3,700 tons
Reinforcing steel	500 tons	350 tons
Structural steel	4,500 tons	2,100 tons
Cable wire	900 tons	300 tons
Railing	8,800 lin. ft.	5,300 lin. ft.
Castings	100 tons	60 tons
Sheet piling left in place	500 tons	275 tons

Those Responsible.—These bridges are being built for Suffolk County through its Board of Supervisors and A. O. Smith, Superintendent of Highways. Robinson & Steinman, Consulting Engineers of New York City, prepared the plans and specifications and will supervise the construction of the work. Booth & Flinn Company of Pittsburgh, Pa., are the contractors for the substructures, and John A. Roebling's Sons Company of Trenton, N. J., are the contractors for the superstructures.

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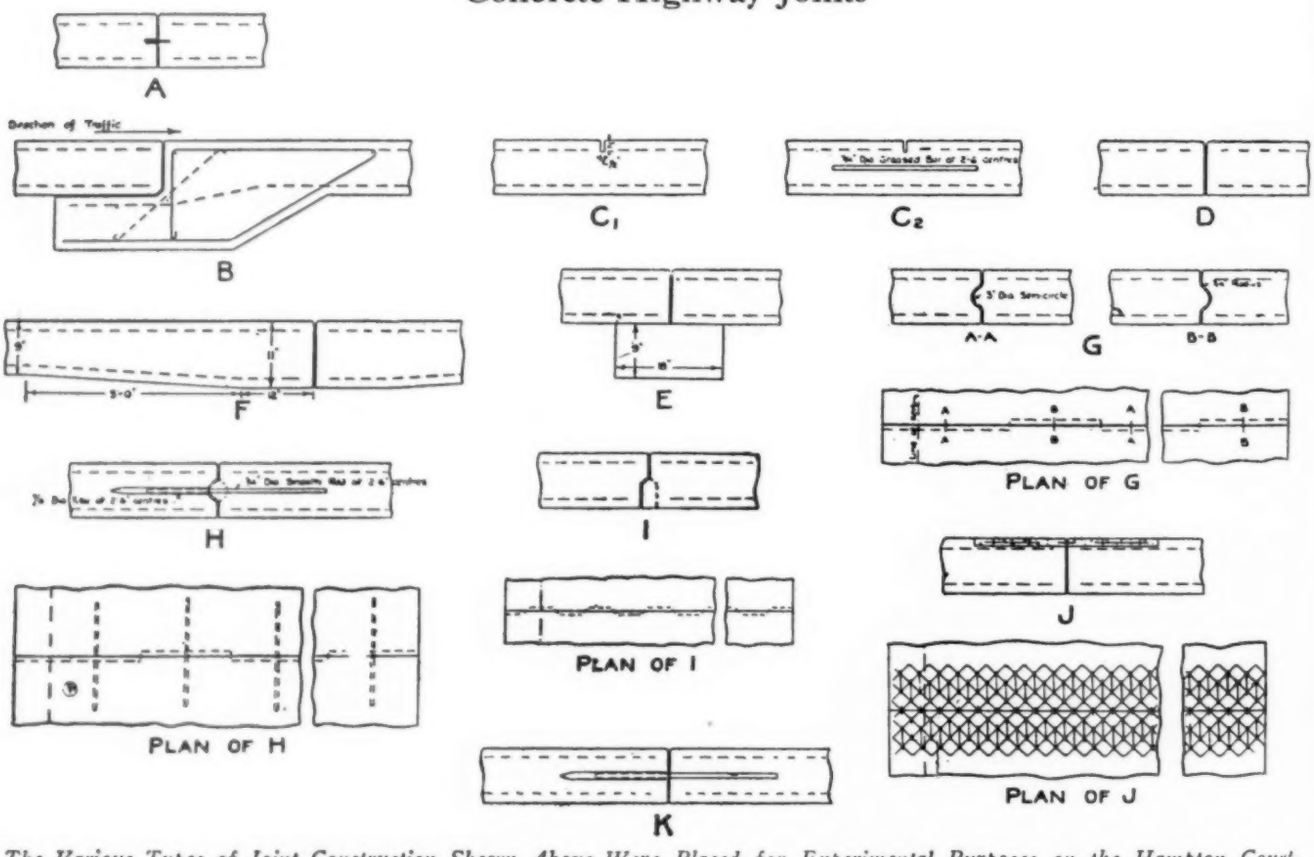
Accident Statistics

MOTOR VEHICLE ACCIDENTS, by R. S. Kirby, Assoc. Prof. of Civil Eng'g., Yale University. Seventh study, 47 pp., 6 in. by 9 in., paper cover. The Hartley Corp., publishers.

This is the seventh study of motor vehicle accidents occurring in the State of Connecticut, including those for the year 1930. The booklet contains statistical data and charts.

Concrete Highway Joints



The Various Types of Joint Construction Shown Above Were Placed for Experimental Purposes on the Hampton Court-Esher Road in England. Data Relative to the Experiment May Be Obtained From the Ministry of Transport, at London, Under Whose Auspices the Investigation Is Being Conducted

Economical
Road Work

Depends
on

Book is Bound in a Stiff Paper Cover with a Suede Finish

ADEQUATE COST SYSTEM

Accurately and Consistently Operated

IT has long been patent to observers and students of road building that one of the main factors in obtaining the construction of proper types of roads and the reduction of maintenance expense is a cost system which will furnish to those who must plan and build roads essential and accurate figures upon which their conclusions may be based. There has been a lack of such system everywhere, but now throughout the country there is apparently a general realization of the important relation which cost accounting bears to road construction and maintenance.

No reason exists why governmental agencies should not exercise for the public, in the construction and maintenance of facilities for the use of the people, the same business judgment that is exercised by those in charge of commercial enterprises. Commercial enterprises must depend upon dividends or they cannot exist. They meet the keenest competition. In order to overcome competition and produce dividends, they must bring to bear in connection with their work the very best in talent, systems, research, and analysis, so that they may construct, operate and maintain economically. Government enterprises are free from the element of competition and are not required to produce dividends, but too frequently insufficient research and study have been given to prevent enormous waste, beyond the thought and work necessary to provide funds for initial cost of construction and tax rates for maintenance.

Before any road is constructed, the type and width must be determined upon. This should be arrived at by consideration of traffic to be handled and the terrain to be traversed, and the maintenance cost of that type under those conditions. Guesswork will not suffice. The most economical type under those conditions depends not alone upon the initial cost, which includes interest charges on the investment, but upon the cost of maintenance of that type over a period of years, and this cost may be ascertained only under an adequate cost system, accurately and consistently operated. Such a system does more—it develops by comparison the point at which that type is no longer profitable to maintain, determined usually upon the cost of maintenance. When the traffic carried has reached its peak for that type, it is time to advance the type. Such a system stops leaks in maintenance costs, shows the kind of maintenance which can be most successfully and profitably carried out, and offers opportunity for study with a view to constant reduction in maintenance costs and improved service. Competent analysis of results obtained, and an application of these results to future work, will bid fair to approach a point where the taxpayer may hope to obtain more for his dollar than heretofore has been possible.

The system in Harris County has been under preparation by us for a matter of years, but its present method of operation of operation and its chances for success have been greatly aided by the use of tabulating machines. The hand method proved slow, and figures could be obtained only with laborious effort, whereas, by the use of these machines and the system designed to get the greatest benefit therefrom, information properly analyzed is available for use in the executive and engineering divisions at will. As related to roads and bridges, it may be of interest to sketch briefly the methods by which these costs are obtained.

Each road in the county is given an identifying number, and is sectionized by types; that is, each road is divided into as many sections as there are types of pavement represented, and each section is given a number. Thus, a half mile of concrete on Road 2001 is designated as 2001-1 (the first numeral "2" indicating Precinct 2), followed by a mile of gravel designated

2001-2, followed by a mile of earth designated 2001-3, et cetra.

Once given a number, all costs thereafter incurred upon the particular road necessarily fall within the section on which incurred, whether for construction or maintenance. Section numbers change only upon the completion of the construction of some section. These changes are made on the records by means of "Change of Type" reports sent in after the completion of any job.

A full description of each road and section, both by number and name, in addition to a road map, is carried in an appropriate file for ready reference, and all road men are furnished with exact copies of the entire road list and sections.

Lump sum costs by roads or bridges do no more than satisfy as to the total. They furnish no basis for comparison with similar totals, because unless reduced to the composing elements there is no proper basis of comparison. No purpose is served by comparing the maintenance cost of a gravel road with that of a concrete road, if only totals are used. It frequently happens that the maintenance on a low type of road is less than it is on a high type of road. This can happen from higher cost of maintenance of elements of the road common to both but having nothing to do with the type of wearing surface.

In arriving at the proper type to be constructed, surface types are the elements to be compared. It therefore becomes necessary to separate roads not only into types, but also into divisions, so that records may be available on the maintenance cost of the surface, shoulders, ditches, structures, et cetera. Thus, as labor or material is used upon roads, it is appropriately designated to the portion of the road upon which it is to be used. It is simple, when costs are treated in this way, to take from the cost of any type all of the items except those desired for comparison, so that the cost of surface may be compared with surface, shoulders with shoulders, ditches with ditches, and so on. This results in exact cost comparisons for any type and for any portion of the road of that type.

Bridges are treated in a similar manner, each structure over 200 ft. in length being assigned a section number. It has even been found desirable to separate the approaches from the main structure, particularly where it is of different material, and it becomes possible by this system not only to ascertain the cost of constructing or maintaining the bridge, but the particular portion of the bridge on which the cost has been incurred, and the elements that went into it. There are, therefore, in competition wooden, creosoted, metal, concrete, and other types. The traffic being known, the time of construction being fixed, the cost of the construction of that type being known, and its maintenance by parts being available, there is before those charged with the duty of constructing bridges in the future, data upon which to base an accurate estimate as to type.

The value of these maintenance costs, of course, becomes greater with passing years.

Under this system, each individual piece of road machinery, or equipment is assigned a number, and reports are made daily by foremen in charge, showing the hours the particular piece of equipment is operated on any given section of road, or on several sections. The slips further show the gasoline or oils used, and repairs to the machinery. These charges are held in suspense and at regular periods are broken down and pro-rated out to various roads on the basis of hours actually operated on those roads. This is also true of initial cost, which is charged out in the same way. This method enables a far more precise cost to be obtained than has heretofore been the case. In many municipalities, the cost of equipment is carried as a separate account and never gets into the roads on which the equipment actually worked.

Engineering, inspection, and similar costs are cared for in much the same way. Field parties make daily reports on the particular road and section on which they are engaged. Inspectors, foremen, and others do the same. Pay rolls are made up on a basis of these slips, and when paid, the time is distributed immediately and directly to the road, and to that part of the road upon which the work has been done.

At the end of the year all of the expenditures for road purposes are available already distributed directly to the road or bridge, and it is a simple matter to pick up at once the total cost of any road or section or type, or accumulate that information by roads or precincts, and to make any and all comparisons necessary to determine any cost that is desired. The hit and miss method has been entirely eliminated. Average costs are obtained which immediately inform those interested whether costs are running too high upon any particular type.

Money being allotted for budget purposes may be figured with some degree of accuracy, and the resources of the county conserved in that respect. A precinct having a known mileage, consisting of various types, has allotted to it the amount shown necessary to maintain those particular types under given conditions, the

TABLE OF ROAD VALUATION RATES BY

December

Type	Average Valuation Rate per Mile Used by County Engineer in 1927—No Width Specified—See Annual Report That Year		Valuation Rate per Mile						
	Minimum	Maximum	7 Feet Wide	8 Feet Wide	9 Feet Wide	10 Feet Wide	12 Feet Wide	14 Feet Wide	15 Feet Wide
Brick									
Concrete, Bituminous									
Concrete	$ 30,000	$ 38,000						$ 23,070	
Macadam, Combined with Gravel or Crushed Rock Base, Surface Treated	15,000	15,000							$ 15,650
Macadam, Combined with Shell Base, Surface Treated	14,000	14,000							
Rock Asphalt, Gravel Base	15,000	15,000							
Rock Asphalt, Shell Base									
Gravel, Surface Treated	12,500	12,500					$ 7,000	8.000	
Shell, Surface Treated	12,000	12,000				$ 6,000	7,190	8,000	8,600
Asphalt, Rock—Cold Laid									
Asphalt, Kock—Hot Mixed									
Gravel	8,000	8,000		$ 4,450		4,790	5,540	6,300	6,670
Shell	6,000	6,000	$ 4,000	4,000	$ 4,500	4,900	5,640	6,500	6,800
Macadam									
Rock, Crushed	10,000	10,000							
Earth, Black Land	500	500							
Sand	500	500							

average upon which the allotment is based being an average of all miles maintained of the particular type affected. This is a fair basis of allotment, and guards the funds against extravagance. It is true that some types run higher in places than the same type will run in other places, but the basis used is still the average, which works fairly for all concerned. It is also true that hand in hand with these averages and with this

Throughout the Text are Beautiful Sepia-Finish Pictures of Points of Interest in Harris County, Texas

system must go engineering or similar adequate inspection, or else the value of the figures is decreased. For instance, inclusion of types inadequately maintained serves to throw average out of line.

In awarding contracts for construction, the unit basis is used, so that costs may be analyzed as to items as well as by totals, and this policy has resulted in more uniform bids and in lower initial cost. Every item entering into the cost of any job must be set out clearly, and lump contracts are avoided.

As a final part of the system established, the regular publication of the data obtained, with proper analysis, is maintained for private and public distribution. This offers a further safeguard to the extravagant use of public funds, and an incentive to those officers charged with the administration of county affairs not only to administer wisely the affairs of the county, but to avail themselves of the information by which it may be done economically.

Almost every function of the county government makes some contact, financial or otherwise, with the county auditor's department. As a matter of information to county taxpayers, and because the information is not available elsewhere in compiled form for public reference, the county auditor of Harris County, Texas, included statistical data on the activities of the county engineer's office in his annual report. Attention, in Harris County, is being directed to the possibilities of lower governmental costs, so far as highway work is concerned, through the following methods:

1. Better business methods.
2. Budgeting of highway funds and accounting for their expenditure.
3. Comprehensive planning.
4. Standard construction, and
5. Regular and systematic maintenance.

Among the policies contributing to the sound financial basis which has been effected in the county are the following:

1.—Operation of county upon a strict cash basis—that is, operation during each budget period with the funds in hand at the beginning of the year.

2.—Adherence to a definite budget.

3.—Purchasing based on competitive bids.

4.—Retirement of bonds in advance of maturity.

This last policy has resulted, during the past 15 years, in a saving of some $400,000 of interest through the redemption of approximately $1,307,500 worth of county and district bonds. All sinking funds are up to the standard required by law. The sinking funds of the long term issues are, for the most part, invested in high class municipal securities of local issue, in some cases bearing higher rates of interest than the issues the funds of which are invested.

All bond funds are devoted exclusively to capital improvements. Current funds for general purposes are devoted for the most part to operation and maintenance, but for road purposes, the policy of semi-permanent construction out of current road and bridge funds is being steadily pursued with favorable results. This is best illustrated by the following: In 1926, $418,703 was expended from road and bridge funds for maintenance of roads and bridges, and $202,843 for construction; whereas, in 1930, $380,663 was expended for maintenance of roads and bridges, and $481,369 for construction.

The balance sheets and tabulations in Harris County's

TYPES (EXCLUSIVE OF RIGHT OF WAY)
31, 1930

Fixed by County Engineer in 1929, by Widths, Used for Valuation Statements in 1929 and 1930

16 Feet Wide	17 Feet Wide	18 Feet Wide	20 Feet Wide	23 Feet Wide	24 Feet Wide	26 Feet Wide	29 Feet Wide	30 Feet Wide	40 Feet Wide	45 Feet Wide	50 Feet Wide	56 Feet Wide	60 Feet Wide
													$ 118,774
$ 28,370			$ 52,040										111,160
26,370		$ 28,320	34,680		$ 39,560					$ 74,180		$ 92,310	94,730
16,500		18,240	20,300			$ 25,460							
16,500	$ 17,000	18,240	20,300						$ 55,000		$ 65,500		
14,000	15,000	20,000											
		16,350							47,410				
9,000		10,000											
9,100		10,100	11,130	$ 13,500		14,370		$ 16,300	36,000	37,000			
6,950		7,800	8,640										
7,200		7,950	8,840			11,350	$ 14,000		16,700				
		700											
		700											

excellent annual report comment sufficiently on the practices obtaining so that the taxpayers can fully understand the county's business. The section devoted to roads contains statistics, the likes of which the writer has never seen in other reports.

Log of Roads and Bridges.—Road and bridge records in Harris County are kept separately by precincts, by types under precincts, and by widths under types, with a complete separation of county roads and state highways. These records are adjusted currently during the year for all type changes, mileage added to the system, changes in alignment of roads, mileage taken into the city limits, et cetera, so that the record is up to date at all times.

These records are used for a number of purposes, and provide an invaluable reference medium in checking estimates, bills, and pay rolls, and in answering the numerous inquiries in connection with type and mileage data for the county as a whole.

One very important use is in connection with fixing the precinct maintenance budgets in January of each year. The new maintenance allotment to each county commissioner is based on the per mile cost, by types, of all roads in the county for the preceding year, multiplied by the number of miles of each type in his precinct at the end of the year just preceding. For instance: a precinct having no concrete mileage will receive no per mile allowance for maintaining concrete; a precinct having 100 miles of earth roads will receive a maintenance allowance based on earth per mile cost of twice the amount received by another precinct having only 50 miles of earth roads. Total mileage does not control the allotment, but miles of type constitute the determining factor.

Harris County had of record at the close of the year a total of 1,718.79 miles of county roads and bridges (exclusive of state highways). Of this mileage 1,713.74 represents roads, 4.22 miles bridges, and .83 mile underpasses.

Mileage, by types, is as follows:

Concrete, Bituminous	5.96
Concrete	41.64
Macadam, Combined with Gravel Base, Surface Treated	54.93
Macadam, Combined with Shell Base, Surface Treated	13.40
Rock Asphalt, Gravel Base	4.75
Rock Asphalt, Shell Base	1.98
Gravel, Surface Treated	18.64
Shell, Surface Treated	88.17
Gravel	166.76
Shell	303.62
Earth, Black Land	614.70
Sand	399.19
Underpasses, Steel and Concrete	.83
Bridges	4.22
Total County Roads, Bridges and Underpasses	1,718.79

Bridges, by types, is as follows:

	Feet
Concrete	2,575
Concrete and Timber	683
Concrete and Steel	1,712
Steel	.....
Steel and Timber	325
Timber, Treated	8,357
Timber, Untreated	8,621
Total County Bridges	22,273

COUNTY ROADS—VALUATION STATEMENT
December 31, 1930

Type	Total Mileage	Valuation
Concrete, Bituminous	5.96	$ 307,150.00
Concrete	41.64	1,476,000.00
Gravel, Surface Treated	18.64	152,850.00
Macadam, Combined with Gravel Base, Surface Treated	54.93	941,110.00
Macadam, Combined with Shell Base, Surface Treated	13.40	301,830.00
Rock Asphalt, Gravel Base	4.75	83,000.00
Rock Asphalt, Shell Base	1.98	44,790.00
Shell, Surface Treated	88.17	864,860.00
Gravel	166.76	1,060,380.00
Shell	303.62	1,991,630.00
Earth, Black Land	614.70	430,290.00
Sand	399.19	279,430.00
Grand Total	1,713.74	$7,933,320.00

County Bridges Valuation Statement.—Actual cost prices were used, where available, and estimates of the engineers where cost prices were not available.

The wonderful annual statistical and financial report of Harris County, Texas, is made possible by Article 1665, R. S., 1925, which provides that the auditor appointed by the district judges shall make annual reports to the commissioners' court, setting forth: "* * * all facts of interest, * * * the condition of each account on the books, * * * such other information and suggestions as he may deem proper, * * *."

It was prepared under the supervision of H. L. Washburn, County Auditor, and compiled under the immediate direction of Miss Elizabeth Phelps, Assistant Auditor. The "Road Section" was prepared by direction of and under the supervision of Charles R. Haile, County Engineer.

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County Day Labor Jobs Held Illegal

Day labor operations carried on extensively by the county road construction boards of Iowa have been sharply checked by a recent decision of the state attorney general that all road or bridge building projects costing over $1,500 must be advertised for bids and let at a public letting. The opinion of the attorney general on county day labor operations was requested by C. C. Coykendall, administration officer of the highway commission. The decision cites the state law which provides that road construction work exceeding $1,500 must be advertised for bids. The law states that the board may reject all bids and may readvertise or let the work privately at a cost not exceeding the lowest bid received or may proceed to build by day labor.

The attorney general said that if the board did reject all bids and proceed with the construction by day labor, it must see to it that the cost of the project does not exceed what it could have been done for by contract. "If the cost of the construction work when done by day labor should exceed the cost that the work could have been done for under a contract, such a procedure might be construed to be unlawful," he states.

Another plan which has been followed by several county boards to avoid having to comply with the provisions of the law is to split the construction work up into small projects, none of which cost over $1,500. The opinion of the attorney general in regard to this practice was also asked. Although the board has some discretion as to what constitutes a "project" it cannot arbitrarily cut the work up into projects so as to avoid complying with the law, the attorney general states. For instance, he said, if a five-mile stretch of road is to be graded, the board cannot divide it up into five projects each costing less than $1,500—Building News.

New Equipment and Materials

New Power Driven Mower

A new mower for Models 10 and 15 "Caterpillar" tractors has been announced by the Caterpillar Tractor Co., Peoria, Ill. Some of the outstanding features claimed for this mower are:

Unusually sturdy and strong. A double-acting automatic safety device is provided. If an obstruction gets between the sickle section and guard stopping movement of the cutter bar, the power is immediately released by a snap clutch. Should the forward motion of the sickle bar be prevented by its striking an obstruction, the sickle bar pull rod automatically disengages, releasing the cutter

New Caterpillar Power Driven Mower

bar which may then swing completely around to the rear of the tractor. The snap clutch is mechanically released by a cam and lever at the same time. The sickle bar is brought back into normal cutting position and the ball of the pull rod snaps into its socket. Longer life and easier running of moving parts is assured by the pitman crank being placed in such position that the pitman rod constantly runs in almost the same plane as the cutter bar. The extra heavy 7-ft. length steel sickle bar is sufficiently strong to withstand the heaviest type of mowing service. Heavy balance springs insure quick and easy lifting on turns.

The pitch of the sickle bar is controlled from the operator's seat by a conveniently placed lever.

Both ends of the pitman drive shaft are carried on adjustable tapered roller bearings.

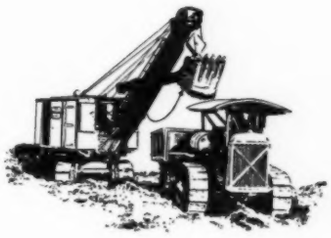
The mower is flexible at the point of attachment to the tractor, and also at the heel of the sickle bar.

The mower drive may be disengaged by merely shifting the power take-off throw-out lever.

The heel and complete sickle bar is fully, quickly and easily lifted from the ground by a lever conveniently placed at the operator's left hand.

Removing four bolts and uncoupling the drive chain completely detaches the mower from the tractor, leaving the tractor free for other work.

For moving from job to job, the mower is transported with the sickle bar in a vertical position, it being firmly locked to the tractor and provided with ample ground clearance.



New 3/8-Yd. Full Cycle Shovel

A new 3/8-yd. full revolving shovel has been brought out by the Bay City Shovels, Inc., Bay City, Mich. This Model B, convertible shovel, crane and excavator with 3/8-yd. bucket capacity, full measure rating on line of plate basis with crane capacity of five tons and convertibility including clamshell, dragline, skimmer, trench hoe and other attachments was first displayed to the general public at the Detroit Road Show. The machine weighs 27,000 lb., 13½ tons equipped as a shovel. Standard shovel boom length is 15 ft. with optional 17-ft. boom if desired. Crane boom length, 30 to 35 ft.

Bay City Model B in pattern and design is identical with the heavy-duty Bay City ¾ and 1-yd. models. It is offered with optional power McCormick-Deering 40-hp. power unit or Hercules 4½-in. bore, 5¾-in. stroke. All Bay City features are built into this machine including powerful chain crowd, heavy unit cast car body, unit cast revolving machinery table, heavy-duty patented swing lock, frictionless New Departure and Timken bearings on all machinery shafts, large 7-in. center post and wide diameter swing circle, double lubrication, electric welded shovel boom of heavy plate construction with divided sticks with gear and rack crowd.

Some of the features of the new model are: E-Z finger clutch control, machine cut gears throughout, cut from alloy steel blanks, boom foot located directly over table rollers on cast machinery table less than 30 in. from center post, safety type worm boom hoist, line of plate measure shovel bucket with cast manganese front and back with reversible detachable teeth, long crawlers, two propelling speeds forward or reverse—⅞ and two miles per hour—well lighted, roomy enclosed cab with room to walk behind power unit, patented crowd chain adjustment permitting any change of shovel boom angle without disconnecting or adjusting crowd chain.

Bay City 3/8-yd. Convertible Shovel

New Shoulder Scraper

A special shoulder scraper with hydraulic operation for the maintenance of shoulders has been brought out by the Willett Manufacturing Co., Grand Rapids, Mich. This machine extends out on the road shoulder from the right side of the truck, being braced back to the frame of the truck, and has no extension whatever on the left side of the truck.

A moldboard mounted curved cutting blade 4 ft. long cuts out the ruts, the

Special Willett Shoulder Scraper

rough spots, and the grass and weeds on road shoulders and brings all overflow material up flush with the edge of the pavement. There is always a certain amount of material that overflows slightly on the pavement, which is removed by the rear angling blade, which is held down to the pavement by the means of extra coiled springs. The rear angling blade is 7 ft. long and it not only removes the overflow material from the pavement surface, but it spreads it evenly over the shoulder in the wake of the cutting blade, forming a perfectly smooth shoulder flush with the pavement edge.

The scraper is powerfully built; usual operating speed 7 to 8 miles per hour. The hydraulic power unit also lifts both blades when desired, giving ample road clearance for transporting the machine from place to place. The machine may be removed from the attachments that support it to the truck frame and a regular gravel and dirt road maintenance Willett spring-scraper mounted thereon.

Highway Guard

A post for highway guard installations consisting of a rolled steel H section to which is attached a steel spring by means of two U-bolts has been placed on the market by the Pottstown Metal Products Co., Pottstown, Pa.

The cables pass through loops on ends of the springs and are free in the loops. The heavy spring is claimed to not only hold the cables well away from the post

Installation Along a Delaware State Highway

but also to cushion the force of the blow thus protecting both vehicle and fence.

It is claimed that the flat surfaces offered by the rolled steel H section provide greater resistance to the ground than a round post and this feature together with the much greater strength permit a wider spacing and consequently reduces the initial cost.

An installation of over 10,000 lin. ft. of this product has been made along a state highway in Delaware between Delaware City and Port Penn.

New Post for Reflector Signs

A new type of post for mounting button type reflector signs has been perfected. The post is 7 ft. long, formed from 13 gauge steel channel section with a pressed stiffening rib. The bottom end is formed for driving into the ground or it may be set in concrete.

Heavy steel U-clips are welded to the post at the proper points to accommodate standard spacing of bolt holes in signs. Bolts introduced through the sign pass through the post and the clip. The points of each clip project beyond the plane of the channel a sufficient distance to give clearance to the "button box" containing the reflecting portion of the sign. Thus the sign has two-point contact, is rigidly attached and suffers no distortion.

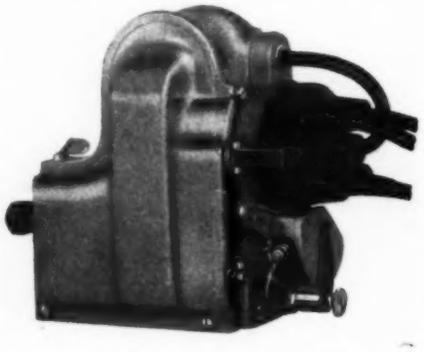
The assembled sign cannot be twisted in the ground, is strong enough to prevent its being bent permanently but with a degree of resilience enabling it to withstand a severe blow without injury to sign or post. The new post is manufactured by The Toledo Pressed Steel Co., Toledo, O.

New Post for Reflector Signs

New Wico Type D Magneto

A new magneto has been announced by the Wico Electric Co., Springfield, Mass. This Wico Type D magneto differs from all previous models produced by the company in that it is a development of the revolving magnet method of generation. In the Type D, the rotor is reduced in size, affording simplicity and efficiency. Any part of the electrical circuit, either high or low tension, can be checked up with the utmost ease. Some of the advantages claimed for this magneto are:

Because of the independent journaling, no side strain from improper mounting can be imparted to the rotor. Although the conventional impulse coupling is mounted within the housing and is fully protected, it can be readily serviced without disturbance of the generating parts. It possesses long life because it is subjected to much less strain than other magnetos impose on the impulse coupling.



Wico Type D Magneto for Trucks and Tractors

The magnetic rotor literally floats on the stud which it encompasses. The maintenance of an efficient air gap for all time is fully assured.

The cores are 1 in. in cross section.

The two-piece assembly frame, enclosing the distributor gears, acts as a reservoir for a large amount of lubricating oil. An ingenious arrangement circulates the oil freely over the gears, the stud on which the rotor is mounted, and other bearing surfaces. A jump-spark distributor and breaker mechanism of conventional automobile type, so mounted as to be entirely isolated from the lubricated surfaces, complete the assembly.

A New Portable Welder

A complete line of portable engine-driven welders in four sizes has been announced by Schramm, Inc., West Chester, Pa.

These four sizes, 200, 300, 400 and 600 ampere units contain the latest improvements in welders of this type and are capable of welding successfully over a wide range of current. The generator unit is designed for rapid voltage recovery, assuring the operator of a stable and "peppy" arc. A transforming reactor automatically steadies and regulates the arc.

Schramm Portable Welder

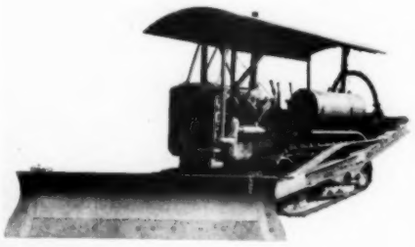
Single-operator welding machines are available, consisting of a variable voltage type of welding generator, direct-connected to a gasoline engine. Also duplex units having two welding generators.

Any of the mountings for portable use can be supplied, such as spring trailer, Highway Trailer, two-wheel pneumatic tired, rubber tired wheels, steel wheels, skidded and for mounting on all standard makes of motor trucks.

New Road Machine for Mountain Work

A new piece of equipment designed primarily for use in building trails has been brought out by LaPlant-Choate Mfg. Co., Inc., Cedar Rapids, Ia. The equipment is built for use in digging on uneven ground, rocks, clay, decomposed granite and any materials found in mountainous regions. It is also designed with a 36-in. lift with a special moldboard, having heat-treated cutting bits at each end of the blade for cutting in the side of the mountain or hill.

Construction details follow: The blade pivot box is an all-steel casting fastened in the center of the blade by means of a vertical I-bolt pin which moves freely in the slot at the top of the casting. A lock pin is provided at the center of the blade which enables the blade to be locked at a 90-deg. angle or straight across the front as a bulldozer. The frame surrounds the tractor, while the side frames are attached to the tractor by means of an oscillating stub-axle carried on the center of the track frame of the tractor from which point the blade is also pushed. The pivot axle runs clear through the center of the tractor and therefore ties the swing frames together.



LaPlant-Choate Road Builder

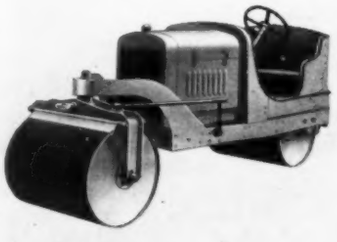
The hydraulic jack is placed in a horizontal position in the rear cross-tie bar of the main frame. This jack pushes outward on a piston, to which is attached a yoke containing a sheave. The dead-end of the cable is attached inside the rear cross-frame, passes around the sheave in the yoke, then around the lower sheave in the sheave bracket over the upper sheave and from there anchoring to the drawbar. This drawbar is made of a one piece cast steel casting with the pullbar jaw attached.

When the oil is forced into the hydraulic jack, the piston goes outward, taking up the slack and thereby raising the front of the blade.

When the tractor is needed for other work, it is merely necessary to pull the two center bearing shafts, which are in split sections, drop the frame on the ground and drive the tractor out over the front.

New Light Roller and Trailer

A new small roller and trailer has been announced by the Superior Construction Equipment Co., Chicago, Ill., general distributors for the Continental Manufacturing Co. This roller can be used for asphalt patchwork, rolling rock asphalt, golf courses, tennis courts, athletic fields, etc.

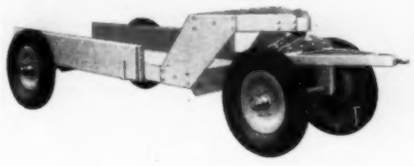


The Banty Roller

The "Banty" roller is equipped with hollow water-tight rollers which allows the weight to be varied by the addition of water. Empty, the roller weighs 2,100 lb.; with both rollers full it weighs 3,000 lb. Any desired weight below 3,000 lb. can be obtained by filling the rollers to the proper level. Specifications are as follows:

Power—15 hp., 4-cylinder heavy duty industrial gasoline engine with electric starter and generator. Clutch—Spring loaded type, operated by foot pedal, drive fully enclosed, running in oil, ball bearings, one speed forward and reverse; housing cast as unit with clutch cover and bolts directly to bell housing of engine. A jackshaft extending to both sides of the frame and supported by self-aligning roller bearing conveys the power to drive sprocket and thence to rear roller by a diamond roller chain. Rollers—Built up of plate steel, electrically welded and watertight, fitted with plug for filling with water to vary weight. Frame—Fabricated steel channels—hot riveted. Speed—3 miles per hour.

The trailer, a useful companion to the "Banty" roller, capacity 2½ tons, can be towed at 35 miles per hour. It can be angle; this is desirable when working in close places. Skids are carried in brackets at the sides, thus they are used as sideboards. The floor is of heavy fir, giving plenty of material for bolting, or spiking down anything to be carried.



The Trailer

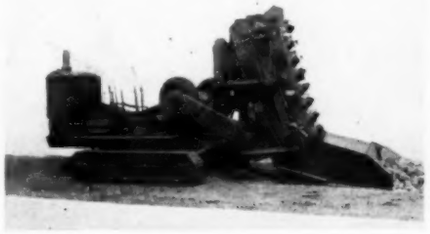
New Self-Propelled Crushing Unit

A new machine has been developed by the Rogers Iron Works Co., Joplin, Mo., for the purpose of picking up gravel which has been previously bladed into a windrow; elevating, crushing, screening, and returning it to the road.

The machine is a self-contained, self-propelled and self-feeding unit, built in either crawler or wheel type. Each type serving a distinct field. The crawler type is better adapted to new construction where roadbeds may at times be soft and the tractive effort of the wheel type machine would be inadequate. This type is furnished with a speed range of from 4½ ft. per minute working speed to 2 miles per hour road speed.

The wheel type machine is more adaptable to maintenance work where a good firm road bed exists and there is no necessity for the crawler tread for added traction. This machine also has the advantages of being lighter and more mobile, its speed range being from 8 ft. per minute working speed to 10 miles per hour road speed.

The loading elevator for picking up the windrow material is of very heavy construction. It is furnished with a specially designed boot, the flaring sides of which, direct the material into the path of the loader. The design of the boot is such that after having passed over the road, the surface is left clean and free from any appreciable amount of oversize material. After the material is picked up by the loader it is elevated and delivered to the crusher for reduction, which discharges onto a shaker screen of ample size. The undersize product of this screen drops onto the road forming a windrow of specification material beneath the machine. The oversize material is passed forward into the boot of the loader from where it is again picked up, elevated and again delivered to the crusher where it is reduced to a size which will pass the screen. In this way a closed circuit is maintained which precludes any possibility of material being placed on the road surface which has not passed through the screen.



Rogers Self-Propelled Crushing Unit

Although the crusher is powered from the same plant which furnishes power for the road movement of the machine, its operation is independent and it may be started or stopped at will. Another feature has been incorporated in this machine consisting of a conveyor mounted underneath the screen discharge, and extending to the rear. In operation the material from the screen falls on the conveyor belt which discharges into a bucket elevator mounted on the rear of the machine. The elevator being of proper height to permit stock piling or loading into trucks. This feature permits the use of the machine at a stock pile or at any point where there is an accumulation of material to be crushed.

New Purox Regulators

The Linde Air Products Company, 30 East 42nd Street, New York, N. Y., has recently introduced an entire series of new and improved Purox oxygen and acetylene regulators superseding its former line of Purox Metal Master type of regulators. All Purox welding or cutting outfits now include these new regulators where formerly Metal Master regulators were supplied as part of the regular equipment.

The new Purox series comprises six regulators, designated as Nos. 33 and 34 for acetylene; Nos. 13, 14, 23 and 24 for oxygen. All regulators in this series have the same general external appearance. They are of all-metal construction, simple, compact, rugged and workmanlike in appearance and thoroughly reliable in performance. The required volumes of oxygen and acetylene essential for maintaining a neutral flame at the blowpipe tip are delivered to the welding or cutting blowpipe at uniform pressure.

One of the outstanding design features of the new Purox regulators is an accurate self-aligning valve of the nozzle and yoke type, insuring sensitive action and freedom from leakage. Simplicity of construction also eliminates any need of disturbing the diaphragm, bonnet, pressure adjusting screw, or pressure adjusting spring when replacing a worn valve seat. Access to the interior of the regulator is gained by merely removing a plug in the rear of the body. The seats are made of a material not easily marred, scratched or damaged by foreign particles that might find their way into the inside of the regulator.

Purox No. 34 Acetylene Regulator

The diaphragms are made of a special corrosion-resisting alloy assuring long life. A rupturing disc safety release on the oxygen regulator provides protection to the diaphragm should an abnormal pressure occur. Although seldom if ever necessary, the operation of replacing the diaphragm is quite simple. The cap bolts are merely removed and the diaphragm and yoke lifted out, no special tools being required.

Gauges for the new Purox regulators are heavy and well made in order to withstand the incidental rough usage of field work. The cases are polished brass with beveled plate glass crystals. The working pressure gauges are 2 in. and the cylinder pressure gauges 2½ in. in diameter.

Purox regulators are listed as standard by the Underwriters' Laboratories and the Factory Mutuals Laboratories.

Bucket for Placing Concrete

Blaw-Knox Co., Pittsburgh, Pa., has acquired exclusive manufacturing and sales rights of the Wiley concrete bucket, formerly manufactured and sold by the Dayton Whirley Co., Dayton, O. This product will now be known as the Blaw-Knox concrete bucket.

These buckets are for derrick or cableway operation, but can also be used as floor hoppers for loading buggies, wheelbarrows, or discharging into chutes. The buckets utilize a single radial gate for opening and closing. This gate is extremely easy to operate regardless of the amount of concrete in the bucket, and is stated to give absolute control of the discharge of the aggregate at all times. The bucket is extremely easy to spot just where concrete is required, is watertight and permits full delivery of batch of grout to forms without loss of aggregate. Buckets are made in the hook-on and two line types.

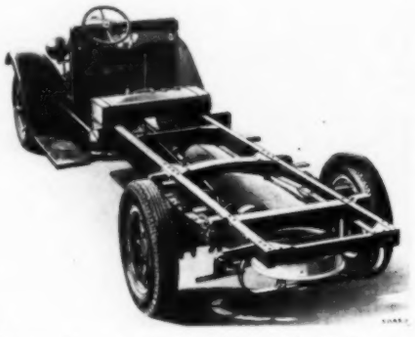
Blaw-Knox Concrete buckets are made in three standard sizes—18, 33 and 63 cu. ft. capacity, respectively. Larger buckets can be made to order, as required.

Blaw-Knox Concrete Bucket

New International 1½-Ton Truck

A new 6-cylinder 1½-ton truck has been announced by the International Harvester Co., Chicago, Ill. This model has a 136-in. wheel base. The model also is available in 160-in. wheel base.

The 6-cylinder engine which powers the new Model A-3 is of the detachable L-head type: 3¼-in. bore by 4½-in. stroke. Its piston displacement is 224 cu. in. This engine develops a maximum brake horsepower of 54 at 2,700 revolutions per minute. Its maximum torque is 138 lb.-ft. at 700 to 900 revolutions per minute. It is unusually economical in fuel and oil consumption. The clutch is of the single-plate type with built-in, vibration damper, while the transmission provides four speeds forward and one in reverse.

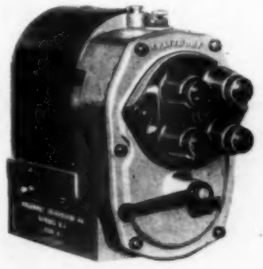


International Model A-3 1½-Ton Truck

The frame is of heavy pressed steel channels, 7 in. deep at the center and reinforced with numerous cross members which assure rigidity with ample flexibility to meet varying load and road conditions. The front and rear springs are of the semi-elliptic type and semi-elliptic auxiliary rear springs are also provided. The rear axle is of the full-floating, spiral-bevel-gear type with axle shafts of chrome-molybdenum steel. Pinion, differential, and wheel bearings are of the tapered roller type. Four-wheel, mechanically operated, internal - expanding shoe-type brakes and the cam-and-lever steering gear provide easy truck control at all speeds. Cast, spoke-type wheels with 30 x 5 front and 32 x 6 rear tires are standard equipment. Dual rear tires are also available.

New Splitdorf Type "C" Magneto

The new Splitdorf Type "C" magneto is an all enclosed high-quality, moderate priced machine of the inductor type, adapted to engines of from 1 to 6 cylinders, inclusive.



Splitdorf Type "C" Magneto

The interchangeable features permit quick changeover of certain assemblies to meet certain requirements of engine manufacturers, without any extensive dismantling. The circuit breaker is of the high speed, stationary type. The solid one-piece front plate lined with felt, prevents dust and water from entering the breaker compartment.

The output of the Splitdorf Type "C" is stated to be fully adequate for all agricultural machinery, trucks, tractors, stationary engines, etc. It will deliver a good hot spark at unusually low incoming speeds. On the strength of incoming speed characteristics, the Splitdorf Type "C" compares favorably with magnetos of much larger dimensions.

The Splitdorf Type "C" magneto operates on the inductor principle. The coil and condenser are rigidly mounted in the top of the magneto. The rotating member is a unit die-casting without wires, contacts, or other electrical parts. This construction is notable because of greater simplicity, greater durability of the electrical parts, because they are entirely separate from the main rotating element, where they are easily accessible for inspection, repair, or replacement.

New Spreader

A new mechanical spreader for spreading sand, gravel, calcium chloride, crushed stone or slag has been brought out by the Adnun Engineering & Manufacturing Co., Nunda, N. Y.

The spreader is simple in design. It is stated it can be attached or detached from any standard make of truck by one man in less than one minute. A ratchet lock and brake wench, connected by a plow-steel cable, permits easy attachment of spreader to a truck of any height.